Explanation and Definition in Physics I 1

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In the first chapter of the *Physics*, Aristotle presents a description of the heuristic process by which the first principles of natural science would be attained:

> The natural course is to proceed from what is clearer and more knowable to us, to what is more knowable and clear by nature; for the two are not the same. Hence we must start thus with things which are less clear by nature, but clearer to us, and move on to things which are by nature clearer and more knowable. The things which are in the first instance clear and plain to us are rather those which are compounded. It is only later, through an analysis of these, that we come to know the elements and principles. That is why we should proceed from the universal to the particular. It is the whole which is more knowable by perception, and the universal is a sort of whole: it embraces many things as parts. (184a16-26)[1]

In the opposition between the 'more knowable/known to us' and the 'more knowable/known by nature', the terms '*katholou*' and '*kath' hekaston*' seem to designate the two extremes of the process of scientific inquiry. On the one hand, the 'universal' seems to be the immediate datum clear to sense-perception and to be further explained. On the

1 This is Charlton's translation. Instead of 'compounded' (*sugkekhumena*), we could also read 'mixed together' (Waterfield's translation) or, perhaps more adequately, 'confused'.

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other hand, the 'particular' seems to be either the explanans itself, or else the point of arrival in which the immediate datum would be finally explained by its appropriate principles and causes. This use of these terms contrasts with another passage, where the sense attributed to them seems to be diametrically opposite: *Posterior Analytics* I-2 *(71b32-72a5):*

> Things are prior and more knowable in two ways; for it is not the same to be prior by nature and prior in relation to us, nor to be more knowable and more knowable to us. I call prior and more knowable in relation to us items which are nearer to perception, prior and more knowable *simpliciter* items which are further away. What is most universal is furthest away, and the particulars are nearest. (Barnes's translation, with some modifications).

Aristotle makes these considerations in order to elucidate the way in which the principles of science should be 'more knowable' (*gnōrimōtera*). He seems to conclude that they must be universals, if they are to be principles. By contrast, the data initially known by us and to be explained by scientific principles are particulars. In this way, there seems to be at least some prima facie inconsistency between *Posterior Analytics* I 2 and *Physics* I 1.

This inconsistency can become a major one, if we analyse the conceptions of scientific explanation that seems to be presupposed in each text. *Posterior Analytics* I 2 seems to conceive of scientific explanation as a kind of generalisation, that is, a kind of subsumption of particular cases under universals. On the other hand, *Physics* I 1 seems to conceive of scientific explanation as a kind of analysis into particular elements contained in universals.

But this first impression of inconsistency is not right. Nothing invites us to imagine an insurmountable gap between the two texts, as though they are representative of two conceptions incompatible with one another, or as though they had been composed in different times of Aristotle's intellectual career. My aim is to prove that there is only a slight terminological discrepancy between the two texts. Even if we can assign a different kind of explanation to each text, there is no incompatibility between them. Quite to the contrary, the completeness of scientific explanation should depend upon an articulate cooperation between the two kinds of explanation. Furthermore, I think that the picture *Posterior Analytics* I 2 builds is not opposite to *Physics* I 1, but it is only a more general picture, under which the picture of *Physics* I 1 can be classified as a more specific one.

A good beginning for my argument is to take the exact meaning of the expressions 'more known/knowable to us' and 'more known/knowable *simpliciter* or by nature'. In the former expression, the word '*gnōrimōteron*' is modified by the clause 'to us', while in the latter it seems to be taken in its primitive or more fundamental sense.[2] The meaning of this word can be understood according to a general rule: a predicate *F* is more properly assigned to an item which is not only an *F*, but also a cause by which other items are *Fs*.[3] Thus, in these conditions, a cause is always *F*-er than its effect. Applied to the word '*gnōrimon*' ('known/knowable'), this rule allows us to say that the cause responsible for the knowability of the consequences is more knowable than the consequences, since it is in virtue of the cause that the consequences can receive the predicate 'known'. In this way, in *Metaphysics* I 2, 982a30-b4, Aristotle takes the causes as more knowable ('*malista epistēton*') because the 'subordinate items' are known from them and through them, whereas the causes themselves are not known from and through the 'subordinate items'.[4] An item deserves the designation of 'more knowable' if it stands in a causal relation to another. Applied to notions, this expression can designate more primitive concepts through which others must be elucidated. But, taking the expression in this way, we risk overestimating an epistemological aspect which is not the most important. Applying the expression to propositions, we get its proper sense, or at least the sense most important in *Posterior Analytics* I 2: a '*gnōrimōteron*' proposition is a premise from which conclusions can be deduced. Ultimately, the principles are '*gnōrimōtera*' inasmuch as the conclusions are to be known through them and from them. Thus, '*gnōrimōteron*', without qualification, has little to do with evidence and other

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2 In 71b34-72a2, the expressions 'prior by nature' and 'more knowable' are used together in contrast to 'prior to us' and 'more knowable to us'. In 72a3, Aristotle, developing this contrast, seems to take 'prior simpliciter' and 'more knowable simpliciter' as equivalent to 'prior by nature' in 71b34 and 'more knowable' in 72a1. This last expression is introduced as an absolute one, with no kind of qualification.

3 This rule appears in *A Po* 72a29-30 and *Metaph* 993b24-25. Lesher [1973], 62-5, appealed to it in order to overcome some problems about the interpretation of the terms '*akribesteron*' and '*alēthesteron*'. I believe that it can be applied appropriately also to the case I am considering.

4 I thank an anonymous referee for pointing me to this passage of the *Metaphysics*.

epistemological concepts; rather, it is to be applied to items which have explanatory power.[5]

On the other hand, the qualification added by the phrase 'to us' takes the word '*gnōrimon*' in a sense very common in Greek ordinary usage: 'familiar', that which we are generally acquainted with. Thus, 'more known/knowable to us' is applicable to items more familiar to our ordinary perceptions of the world. It means a priority concerning the subjective origin of the notions in our soul.

To sum up the point: Aristotle applies the denomination of '*gnōrimōteron*' to a premise from which conclusions can be deduced.[6] For it is 'more known' ('*gnōrimōteron*') that which, being known ('*gnōrimon*') in itself, is also a cause by which other items can become known ('*gnōrimon*'). Consequently, inasmuch as a principle is something able to explain other things, that which can explain a greater number of things is *more of a principle* and so is *gnōrimōteron*. Thus, a premise from which can be deduced a greater number of consequences will be *more of a principle* and *more knowable* than another premise, from which a lesser number of consequences can be deduced.

But this criterion can be taken in two aspects. In one sense, from a universal proposition, the same feature can be proved about a great number of things. Since the things under the universal would provide us with minor terms, about each of these we can state the same feature attributed to the universal. In another sense, from a universal proposition, many features can be proved about one and the same thing, inasmuch as we analyse the universal predicate into its elements and transitively assign these elements to the initial subject.[7] These two as-

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5 Wieland [1975], 129-130, and [1993], 89-106, is right to say that '*gnōrimōteron hēmin*' is applied to the previous knowledge that frames our ordinary background; but he is not right when he says that '*gnōrimōteron haplōs/phusei*' has a mere protreptical origin and sense. Barnes [1995], 96-7, and Scholz [1975], 56-7, seem to have understood '*gnōrimōteron phusei*' as an epistemological notion, having to do with certainty and/or evidence. That view does not seem right to me.

6 See the characterization of the proper principles of demonstration in *A Po* I 2, 71b19-33.

7 It is true that transitiveness does not hold for every kind of predicate, or at least so Aristotle conceives. Some kind of coincidental predicates do not admit transitiveness (see *A Po* I 22, 83a25-8, *Metaph* IV 4, 1007a32-3). But, to my point, it is enough to consider that at least essential predicates admit transitiveness, and this transitive-

pects stand in a relation of inverse proportion. A more universal predicate can be attributed to a greater number of things, but can be analysed in a lesser number of constitutive elements. A less universal predicate can be attributed to a lesser number of things, but can be analysed in a greater number of constitutive elements.

It is not difficult to see that these two aspects are not incompatible and can answer to different contexts of scientific inquiry or to different concerns in the work of science.[8] But, for the moment, let us suppose that there is an opposition between two kinds of explanation. According to one conception, to explain would be to group the data under wider classes. The propositions describing the universal properties of these classes would function like laws able to cover the particular cases. In this way, to locate a thing in a universal kind would be to subordinate it to a general rule able to predict its behaviour. And the explanatory power of a rule would be proportional to the level of its universality: the first principles would be the most universal notions or the most universal propositions, applicable to the greatest number of things.[9]

According to another conception, to explain would be to define a thing, i.e., to state what it is, enumerating the whole of its essential

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ness is another way to *increase* (*auxesthai A Po* 78a14) syllogisms, besides the one described in this paragraph.

8 The idea that Aristotle recognises at least two stages in the explanatory work of the sciences has received widespread agreement. Ferejohn [1991], 19, sees Aristotelian *apodeixis* as a 'two-stage affair', in which the syllogistic chains are preceded by a 'framing stage' performed by Aristotelian division, which organizes and gives existential import to 'merely universals' definitional starting-points. Bayer [1997], 131-2, 135-6 states that to explain is not to classify, for the classification performed by selection of commensurate universals is a mere introductory work to the real explanation. In the same way, see Lennox [2001a], 46-8, 51-3: the *historia*, which establishes the commensurate universals, is a predemonstrative and preliminar work, and the explanation that states the causes and answers the 'why' question also states what the thing is. See also Lennox [1987], 92, 97.

9 This conception of explanation as classification in wider classes becomes similar to the Hempelian pattern, once we realise that the classes have a propositional content about the manner of being of the items they include. Classification asserts, for instance, that 'horses are animals'; but this means that, inasmuch as 'animals are so and so', we can infer (and, in some way, predict) that 'horses will be so and so and behave in such and such a way'. To classify is to put an item under a more general law, from which we can state its properties and its usual behaviour.

properties and differentiations. A thing would be more properly and fully explained, not if it has been subsumed under a generic feature or rule, but if it has been analysed in the whole of its constitutive elements.

Now, is this the contrast that we can find in our initial texts? One might claim that the rules set out in *Posterior Analytics* seem to be committed to the former kind of explanation.[10] If this assumption is right, the terminology of *Physics* I 1 will be a clumsy infelicity, or will be representative of another conception of explanation. For if explanation is of the former kind, it is unreasonable to assert (as in the *Physics* passage) that the universal is the immediate datum to be explained, whereas the particular is the explanans to be reached through inquiry — for it is the contrary that should be expected. But we could only find that contrast in the texts if the meaning of the terms *'katholou'* and *'kath' hekaston'* were the same in both texts, and if the only important feature in the contrast between them was the level of generality. But I intend to show now that this is not the case.

There is no indication in *Posterior Analytics* I 2 that the correlation between *katholou* and *kath' hekaston* should be understood merely as a correlation between levels of generality (e.g., between genus and species). Aristotle is just employing a terminology he usually employs: *'kath' hekaston'* means an individual or particular phenomenon empirically given to sense-perception, whereas, on the other hand, *'katholou'* means only a universal concept, in whatever level of generality, in opposition to immediate data. This terminological use provides us with an opposition between empirical data, which is grasped more or less immediately by sense-perception[11] (that is, particular phenomena or individuals) and, on the other hand, concepts to be apprehended by scientific knowledge (that is, universals understood as explanatory notions).

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10 Barnes [1992], 97, commenting 71b33, proposes the following rule: 'if *P* is more familiar by nature than *Q*, then *P* cannot be less general than *Q*'. But if *'gnōrimōteron phusei'* (in Barnes's translation: 'more familiar by nature') points to a greater explanatory power, as I am claiming, Barnes's rule at least suggests a close tie between level of generality and explanatory power, so that a thing would be more fully explained according to the greater generality of its principle.

11 I will not go into the details of this issue; for the sake of my argument, I have deliberately oversimplified it. But it is surely true that, for Aristotle, apprehension of an individual is not an outcome of mere sense-perception, but rather a complex cognitive process, which in some way involves a cooperation of *nous* and *aisthēsis*.

This use of these terms also appears in other passages: in *Posterior Analytics* I 31, 87b37-9, in *On the Soul* II 5, 417b22-3, and in the initial chapter of *Metaphysics* (981a5-12, 15-24). In all these texts, Aristotle states that *aisthēsis* is responsible for the knowledge of *kath' hekaston*,[12] and, no matter what this *aisthēsis* is, the result is the same: the '*kath' hekaston*' designates the ordinary information we are initially acquainted with. This information is almost always particular: a particular instance of a lunar eclipse (88b39 ff.), individuals like Socrates and Callias (981a8-9, 19), etc. But Aristotle did not say that it cannot be universal in some way, nor did he say that a piece of information is universal in the relevant sense because it is attributed to many particular events or individuals. A piece of information becomes universal in the relevant sense if it has explanatory power and can receive the designation of 'knowledge' (87b33-88a2). If we *perceive* that the triangle has its internal angles equal to two right angles, this perception would still be in need of further explanation (87b35-7) and would not be 'knowledge'.

Thus, between *katholou* and *kath' hekaston*, there is not a mere quantitative difference in levels of generality; there is rather heterogeneity. What defines an item as *kath' hekaston* is not its particularity (even if all *kath' hekasta* were particulars), but the fact that it is an immediate datum that requires explanation. On the other hand, what defines an item as *katholou* in the relevant sense is not its applicability to many instances (even if all *katholou* were applicable to many instances), but its explanatory power.

On the other hand, this contrast between explanatory power and unexplained immediate evidence is inverted in the use of '*katholou*' and '*kath' hekaston*' in *Physics* I 1. In this passage, *katholou* is a whole to be divided or analysed, whereas *kath' hekaston* seems to be the elements furnished by that division or analysis. But Aristotle says nothing about the level of generality of these notions, nor about a presumed role to be played by the level of generality in the explanatory efficacy of them.[13]

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12 See *Metaph* 981b10-12.

13 About the level of generality, I think that the use of *Physics* I 1 is not incompatible with the habitual doctrine: a *katholou* is attributed to a larger number of items, whereas a *kath' hekaston* is attributed to a narrower range than the *katholou*. This contrast between *katholou* and *kath' hekaston* can be found in whatever level of generality, as we can see in *Parts of Animals* I: see specially 642a25-6 and 644a25-30 ff. Balme [1960] and Pellegrin [1987] have proved that the use of '*genos*' and '*eidos*'

Even so, we can ask ourselves what kind of explanation this use of the terms *'katholou'* and *'kath' hekaston'* would imply. The process from *katholou* to *kath' hekaston* cannot mean a subsumption of particular cases under more universal laws, nor an application of universal rules to particular instances. Quite to the contrary, this process means an analysis of a whole into its constitutive elements. In this text, 'universal' designates the features more known to us by sense-perception. These features are so called because they are common to various objects, inasmuch as this kind of universal 'is a sort of whole' (184a25) which we perceive not in all its articulations and its inner diversity, but as a sort of crowd of objects which share certain features (and only certain features) in common. Indeed, these features do not comprehend a full characterisation of those objects, but only allow a preliminary identification of them. Each of those objects is classified under the same class and is marked by the same feature, but none is fully known in its own properties.

Thus, the work of scientific explanation consists in a discrimination of the elements of confused generic universals. The causes and principles which provide us with full knowledge about natural things are their essences.[14] According to this, scientific inquiry ought to discern differences of the preliminary data and so to specify the particular essential properties of each natural object initially contained in the *'katholou'* crowd. In this way, by 'division' of the initial muddled mixture, i.e., by an analysis which finds the appropriate elements, the natural scientist is able to reach an exact determination of the essence of each particular item.[15]

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in the biological writings has no taxonomic value, and this position has received general agreement (see Lloyd [1990], 8). I think this position would be equally right about this use of *'katholou'* and *'kath' hekaston'*.

14 I take this for granted. Aristotle is famous for having introduced the four *aitiai*. But I believe that in *Physics* II 7-9 the multiplicity of these *aitiai* is unified in an articulated account of the natural thing. In this account, the form, conceived as equivalent to the *telos* and the *moving cause* (198a24-7), determines a set of material properties necessary to its effectivity (200a5-15). This form, capable to determine its *adequate matter*, is fully responsible for the account of what a thing is and, in this way, can be conceived as the essence (cf. 193b2-3), inasmuch as it is capable of explaining not only the set of functional properties of the thing, but also its behaviour, its capabilities and its material properties.

15 For an interpretation in these same lines, see Wieland [1993], 108. The use of

This process is described in *Posterior Analytics* II 8: we first get to know that a thing exists inasmuch as we grasp some generic features able to ensure an initial identification of it. These generic features can be articulated in a preliminary definition, as when we say that a 'thunder is such a noise in the clouds' or that a 'man is such and such an animal' (93a23-4). Then, we can pursue the investigation a step further, seeking for the more fundamental features which explain why the thing has the properties we initially grasp. These more fundamental features play the role of causes which answer not only the 'why', but also the 'what it is' question: once attained, they can be articulated into the full definition of the thing.[16]

'*diairousi*' at 184a23 can suggest that the task of a natural scientist would be a mere division of universal classes into more specific ones. This suggestion is strengthened once we realize that Aristotle (at least prima facie) takes division as a privileged instrument to build definitions (see *Metaph* 1037b27-30ff., *Parts of Animals* 643b23-24ff.: Aristotle's criticisms are directed against dichotomy, not against every kind of *diarein*). But definitions of natural things can be built also as a hylomorphic account and the *differentiae* that will enter into this account are not mere classificatory notions (see note 16). Thus, the *diairesis* is not a mere classificatory tool, but also an analysis (on this point, Charlton's translation seems to me very proper) that discerns the properties which allow us to define a thing. The evidences for a conception of hylomorphic definitions of natural *ousiai* in *Metaph* VII-VIII are controversial. It is well known that Frede-Patzig and others have denied this evidence. I think they are wrong, for there is enough evidence for this conception in *Metaph* VII 17 and VIII 2-3. But it is enough for my argument to point to the following texts, as evidence for a conception of hylomorphic definitions of natural things: *Physics* II 2, 194a5-7, 12-17; II 9, 200b4-8; *de Anima* I 1, 403a24-b16; *Metaphysics* VI 1, 1025b32-1026a6.

16 These more fundamental features are not a *differentia ultima* (see *Metaph* 1038a19-20), nor mere classificatory notions which will keep the thing separate from all others. In *Parts of Animals* I 2-3, Aristotle does not admit that only one *differentia ultima* could sum up the essence of a thing (see 642b5ff.). He advises the natural scientist to apply simultaneously many lines of differentiation, not dependent upon each other, to reach the form and the definition of the essence (see 643b23ff.). In the same book, he conceives the form — i.e., that which enables us to state what a thing is — as a functional property which subordinates an articulated set of material properties, assumed as necessary conditions to a thing's essence. Thus, it is not mere classificatory notions, but rather the form so conceived that determines fully what a thing is and why it has the properties it has. See 640a16-19, 640b18ff. In this way, Aristotle can say that the 'what it is' and the 'why it is' are questions identical with each other (see *A Po* 90a14-15, and also 93a3ff.: Aristotle states that a definition, which says what a thing is, also displays its cause, by which it exists or is as it is; see Lennox

Physics I 1 pictures this process: from generic features which grant only an unsatisfactory assortment of many things, the natural scientist should attain an exact articulation of all essential properties which constitute each thing contained in that assortment. It is precisely this process that the examples illustrate: the relation between the name and the definition of the circle (184b1-3) is to be understood not as pure logical relation between *definiendum* and *definiens*, but rather as an epistemological relation between preliminary definition, based upon generic features, and a more satisfactory and exact one. '*Onoma*' can be understood as 'designation' — not only the linguistic item which we mark with inverted commas, but also the full logical-semantic fact of using a linguistic item to refer to the world.[17] This designation is the ordinary use of the term, a use that is justified by its repeated efficacy in picking up always the same things, but that is not grounded on reflective criteria. On the other hand, the definition goes beyond this ordinary efficacy of the designation, since it displays the criteria that ground the right use of the term. In a similar way, a child uses a designation in a quite inadequate manner and later learns to use it properly, as if she has as criteria for the use of that designation only some confused and muddled notions (as in a preliminary definition), but later finds the proper criteria (as in an adequate definition).

In the field of natural science, the causes by which we can say that 'we scientifically know' are differentiae which define the essence of things. Some of these differentiae are mere corporeal properties, others are activities, capabilities and dispositions, etc. But, in all cases, they are

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[2001a], 51, 60). In the same way, he can state that the form is the cause of being — that is, the cause by which the thing is as it is — that explains 'why the thing is so and so' and answers 'what it is' (see *Metaph* VII 17, specially 1041b7-9, 25-27; but the same view is also implied in VIII 2, 1043a2-3, VIII 3, 1043b4-14).

17 I think that the use of '*onoma*' can be understood in this way at *Metaph* 982b8 and 1006a30. In the first passage, '*zētoumenon onoma*' does not mean a word or name which is being investigated, that is, whose definition is being searched; it means rather a *designation*, that is, the application of a term to an item which satisfies the relevant requirements for that application; in other words, when Aristotle says '*zētoumenon onoma*', the 'investigation' implied in this expression is a search for a thing to which a designation or name, already defined, can be properly applied. The second text is much more controversial, but I think that '*sēmainei to onoma to einai ē mē einai todi*' can be read as 'the application of a word *F* [to an item *x*] means that [*x*] is (or is not) *G*', *G* ('*todi*') giving the proper criteria for the use of '*F*'.

responsible for the proper constitution of a thing as it is, different from all others.[18] Consequently, they give us the ultimate criteria for a more exact definition of each thing. In order to know scientifically, a scientist should discern these differentiae, and, from a preliminary definition grounded in features a thing shares with others, he ought to proceed to a definition grounded in those differentiae. For explanation is ultimately the account of these differentiae.[19]

Now, the other kind of explanation mentioned above is not incompatible with this one. For, in order to attain a full discrimination of the differentiae, it is quite useful first to gather things under generic groups. The classification of a multiplicity under some generic notion allows us to establish the right sort of explananda. First, the scientist must identify groups by the proper generic features; then, he must proceed to a full specification of the constitutive elements of each thing rightly grouped under those generic features.[20]

There is no incompatibility between the two kinds of explanation I have mentioned. Nor is it necessary to imagine that Aristotle changed his mind concerning the paradigm of explanation to be observed in natural science. But, it is even not correct to believe that *Posterior Analytics* I 2 describes only that kind of explanation concerned with subsumption under generic sorts. For *Posterior Analytics* I 2 only develops a more

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18 See *Metaph* VIII 2, 1042b28-3a7.

19 See note 18. Explanation, as an account that explains why the thing is so and so, turns out to be the same as the definition that states what the thing is. See note 16 for the texts that explicitly establish this connection.

20 See Lennox [1987], 92. He distinguishes two types of scientific explanation: (A) one that explains by a subsumption under a wider class, and (B) another that explains by the object's specific nature. Though sometimes (111) reluctant about the hierarchy to be established between (A) and (B), Lennox asserts (97) that type A explanations in some way prepare the subject for type B explanations. See also the careful distinction between the *historia* (establishment of commensurate universals as relevant *explananda*) and the causal explanations in Lennox [2001a], 46-8, 51-3. I believe that the 'division of scientific work' as proposed by Bayer [1995], 242-4, can be more interesting if reformulated in this direction, as Bayer himself in a later paper ([1997], 131-6) suggests, proposing a distinction between the previous classificatory induction work and the task of finding the real explanations; in this way, the relation between 'identificatory and explanatory syllogism' (see Bayer [1995]) could be understood as a relation between subsuming under genera and specifying the differences. See also Kullmann [1990], 338-41 and his notion of a 'bipartite science'.

general point of view: Aristotle is solely concerned with the full characterisation of scientific principles in general. When he denominates them as 'universals', he is only contrasting them with the ordinary data which provides us with explananda. Aristotle does not say that explanation should proceed, in every case, from the more particular to the more universal, as though explanation was a mere classification under wider classes and as though more universal principles could furnish a fuller knowledge of all things they are applied to. Aristotle says that scientific principles should not only be true, primitive and immediate, but also prior to and more knowable than their consequents and, finally, causes responsible for their consequents (71b20-2). But all these predicates are quite well suited to specific differentiations by which we can state what a thing is and why it is as it is.

Therefore, there is no contradiction between the characterisation of scientific principles in *Posterior Analytics* I 2 and the description in *Physics* I 1 of the heuristic path by which these principles should be attained. There is, indeed, a discrepancy in the sense of *'katholou'* and *'kath' hekaston'*, but this can be explained by the context and terminological malleability of Aristotelian texts. In *Posterior Analytics* I 2, scientific principles are characterised as more knowable by nature inasmuch as they are not only self-explanatory but also able to make other things be known. These principles are not near to ordinary data of sense-perception, but should be attained by further inquiry. In these points, *Posterior Analytics* I 2 and *Physics* I 1 agree with each other. There is only a terminological difference: in *Posterior Analytics* I 2, Aristotle denominates scientific principles as *'katholou'*, whereas in *Physics* I 1 these same principles are denominated rather as *'kath' hekaston'*. On the other hand, in *Posterior Analytics* I 2 *'kath' hekaston'* denominates ordinary data more known to us, whereas in *Physics* I 1 these data are denominated as *'katholou'*. In other words, the opposition between *'katholou'* and *'kath' hekaston'* means in *Posterior Analytics* I 2 an opposition between explanatory concepts and empirical data, whereas in *Physics* I 1 it means an opposition between generic features (understood as data) and specific elements (understood as principles and causes).

Thus, the terminology of *Physics* I 1 is not a mere idiosyncrasy of a clumsy text. It can be perfectly understood under the picture of *Posterior Analytics* I 2. The ordinary data, grasped by sense-perception and more known to us, are equivalent to generic features that many things share in common. These features are not able to discern specific properties of each item to which they are applied. Rather, they include these items as in a confused crowd, 'in a whole', that is, in a whole of yet undifferenti-

ated and undefined things.[21] On the other hand, the principles able to explain ordinary data (and so more knowable by nature) and to be attained by further inquiry (and so less known to us) are not universals more and more undifferentiated and able to include a greater number of things. They are rather differentiations through which each thing can be properly defined, so that a crowd marked off only be generic features can become an articulated whole. And these differentiations fit perfectly well the definition of principles we find in *Posterior Analytics* I 2: they are true, self-explanatory and immediate ('*amesa*', in the sense that they cannot be demonstrated through another *meson*), as well as more knowable than, prior to, and causes of the generic features, inasmuch as they can explain why things have these generic features.

Research in the natural science consists exactly in this inquiry into differentiations and exact definitions, and this explains why Aristotle describes it as a path from '*katholou*' towards '*kath' hekaston*'. According to this itinerary of research, scientific explanation does not consist in a mere inclusion of data in more and more general classes. This work of classification is a mere preparatory step to another kind of work: to discern specific features able (i) to explain why things have the generic features we first are acquainted with and (ii) to ground a definition more satisfactory than the preliminary one.[22]

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21 This expression is taken from Bolton [1991], 9.

22 It is not necessary to conceive these specific features as mere classificatory notions. They can be features of whatever kind, provided that they allow a more exact understanding of the thing they are attributed to. For instance: the interposition of the Earth between the Sun and the Moon, which Aristotle attributes to the lunar eclipse. Through this 'feature' of the eclipse, we can explain why it has the properties we initially have grasped (why it is a privation of light) and we can reach a more exact definition of what it is, for then the eclipse can be defined not only as 'privation of light in the moon' (93a23), but as 'privation of light in the moon by the interposition of the Earth between the Sun and the Moon' (90a15-6). See also the thunder example (94a5-9).

Bibliographical References

Balme, D.M. [1962]. '*Genos* and *eidos* in Aristotle's Biology', *Classical Quarterly*, XII (LVI), 81-98.

Barnes, J. [1995]. *Posterior Analytics*, Oxford, Clarendon Press, 2nd. edition.

Bayer, Greg. [1995]. 'Definition through Demonstration: the Two Types of Syllogisms in *Posterior Analytics* II-8', *Phronesis*, XL, 241-264.

Bayer, Greg. [1997]. 'Coming to Know the Principles in *Posterior Analytics* II 19', *Apeiron*, 30, 109-142.

Bolton, Robert. [1991]. 'Aristotle's Method in Natural Science: Physics I', in Judson, L., ed., *Aristotle's Physics*, Oxford, Clarendon Press, 1-29.

Charlton, William. [1992]. *Aristotle's Physics — Books I and II*. Oxford, Clarendon Press.

Ferejohn, Michael. [1991]. *The Origins of the Aristotelian Science*, New Haven, CT, Yale University Press.

Kullmann, Wolfgang. [1990]. 'Bipartite Science in Aristotle's Biology', in Devereux, D. & Pellegrin, P., edd., *Biologie, logique et métaphysique chez Aristote*, Paris, CNRS, 335-347.

Lennox, James G. [1987]. 'Divide and explain: the *Posterior Analytics* in practice' in Gotthelf, A. & Lennox, J., edd., *Philosophical Issues in Aristotle's Biology*, New York, Cambridge University Press, 90-119.

Lennox, James G. [2001]. *Aristotle's Philosophy of Biology*, New York, Cambridge University Press.

Lennox, James G. [2001a]. 'Between *Data* and Demonstration: the *Analytics* and the *Historia Animalium*', in *Aristotle's Philosophy of Biology*, New York, Cambridge University Press, 39-71.

Lennox, James G. [2001b]. 'Aristotelian Problems', in *Aristotle's Philosophy of Biology*, New York, Cambridge University Press, 72-97.

Lesher, J.H. [1973]. 'The Meaning of *nous* in the Posterior Analytics', *Phronesis* 18, 44-68.

Lloyd, G.E.R. [1990]. 'Aristotle's zoology and his metaphysics. The *status quaestionis*. A critical review of some recent theories', in Devereux, D. & Pellegrin, P., edd., *Biologie, logique et métaphysique chez Aristote*, Paris, CNRS, 7-35.

Pellegrin, Pierre. [1987]. 'Logical difference and biological difference: the unity of Aristotle's thought', in Gotthelf, A. & Lennox, J., edd., *Philosophical Issues in Aristotle's Biology*, New York, Cambridge University Press, 313-338.

Ross, D. [1966]. *Aristotle's Physics*, a revised text with introduction and commentary, Oxford, Clarendon Press [first ed. 1936].

Scholz, H. [1975]. 'The Ancient Axiomatic Theory', in *Articles on Aristotle*, Vol. 1, ed. Barnes, Schofield, Sorabji, London, Duckworth, 50-64.

Waterfield, Robin. [1996]. *Physics* (translation, introduction and notes), New York, Oxford University Press.

Wieland, Wolfgang. [1993]. *La Fisica di Aristotele*, translated by Carlo Gentili, Bologna, Societá Editrice Il Mulino [translation of the 1970 German second edition].

Wieland, W. [1975]. 'Aristotle's Physics and the Problem of Inquiry into Principles', in *Articles on Aristotle*, Vol. 1, ed. Barnes, Schofield, Sorabji, London, Duckworth, 127-140.