Aristotle's *Physics*: The Metaphysics of Change, Matter, Motion and Time

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Seminar admin

Semester plan

Topics:

18.9. Introduction I: Aristotle's concept of natural science, explanation and causation in relation to his metaphysics
25.9. Introduction II: Aristotelian time + Aristotelian space = Aristotelian space-time?
2.10. no meeting (St. Leodegar)
9.10. Physics I, II.1-3: Beginnings and Causes
16.10. Physics, II.1-3: Forms and natures
23.10. Physics II.4-9: Chance, Necessity and Teleological Explanation
30.10. Physics III: Motion and the Infinite
6.11. Physics IV.1-9: Place and the Void
13.11. Physics IV.10-14: Time
20.11. Physics V+VI: Motions
27.11. Physics VII: Movings
4.12. Physics VIII: The First Motion and the First Mover
11.12. The Aristotelian theory of relations and reciprocal powers
18.12. Aristotelian process ontology and the ontological status of lesser entities

Editions, introductions

Editions: I find the bilingual German edition by Hans Günter Zekl in the Meiner Verlag (Aristoteles 1987, 1988) very useful. In the Clarendon Aristotle Series, only five books have been edited:

- Books I and II: Charlton (1970, 1992)
- Books III and IV: Hussey (1983, 1993)
- Book VIII: Graham (1999)

The greek text is available in the Loeb Classical Library: https://www.loebclassics.com/view/LCL228/1957/volume.xml, Thomas Aquinas' commentary is here: http://dhspriory.org/thomas/Physics.htm.

Among the entries on the Stanford Encyclopedia of Philosophy (generally a very good resource) I found useful are the following:

- https://plato.stanford.edu/entries/aristotle/, by Christopher Shields (Shields 2008), which gives a comprehensive but problem-aware and surprisingly non-partisan account of the main strands in Aristotle's philosophy;
- https://plato.stanford.edu/entries/aristotle-metaphysics/ by Sheldon Marc Cohen (Cohen 2016)
- https://plato.stanford.edu/entries/aristotle-causality/, by Andrea Falcon (Falcon 2015b)

- https://plato.stanford.edu/entries/form-matter/ by Peter Mark Ainsworth (Ainsworth 2016)
- https://plato.stanford.edu/entries/aristotle-categories/ by Paul Studtmann (Studtmann 2013)
- https://plato.stanford.edu/entries/aristotle-biology/, by James G. Lennox (Lennox 2017)
- https://plato.stanford.edu/entries/aristotle-psychology/, by Christopher Shields (Shields 2016)

Though not directly on Aristotle, the following are also helpful:

- https://plato.stanford.edu/entries/substance/, sct. 2.1 and 2.2, by Howard Robinson (Robinson 2014)
- https://plato.stanford.edu/entries/plato/, by Richard Kraut (Kraut 2013)
- https://plato.stanford.edu/entries/plato-metaphysics/, by Alan Silverman (Silverman 2014)
- https://plato.stanford.edu/entries/atomism-ancient/, by Silvia Berryman (Berryman 2016)
- https://plato.stanford.edu/entries/analysis/, by Michael Beaney (Beaney 2014), esp. the "Supplementary Document: Ancient Conceptions of Analysis"
- https://plato.stanford.edu/entries/aristotle-commentators/, by Andrea Falcon (Falcon 2017)

In comparison, I found very much less helpful the following entry:

- https://plato.stanford.edu/entries/aristotle-natphil/, by István Bodnár (Bodnár 2012), which uses technical terminology without explaining it, has (or at least seems to have) a psychologist methodology of interpretation (i.e.: lots of affirmations about what Aristotle had in mind or meant to do in such-and-such circumstances, without much textual backup) and uses a lot of unnecessarily anthropomorphic language in the description of natural events.

Bibliography

Translations, with commentaries

- Complete: Aristotle (2014) (revised Oxford Translation, Jonathan Barnes); Aristotle (1936) (trans. and comm. by W.D. Ross); Aristotle (1996) (trans. by R. Waterfield; notes by D. Bostock)
- Books I and II: Charlton (1970, 1992)
- Books III and IV: Hussey (1983, 1993)
- Book VIII: Graham (1999), Wardy (1990)

Commentaries and guidebooks

- Bonelli (2012)
- Bostock (2006),
- Broadie (1984)
- Coope (2001)
- de Gandt and Souffrin (1991)
- Düring (1969)
- Falcon (2005)
- Harry (2015)
- Judson (1991)
- Kaufmann (1893)
- LeBlond (1939)

- Leunissen (2015b) containing: Leunissen (2015c), Lennox (2015), Kelsey (2015), Stavrianeas (2015), Allen (2015), Scharle (2015), Witt (2015), Bolton (2015), Henry (2015), Quarantotto (2015), Charles (2015), Rosen (2015), Leunissen (2015d), Coope (2015), Falcon (2015a)
- Lévêque (1862)
- Mansion (1946)
- Owen (1961)
- Roark (2011)
- Seeck (1975)
- Solmsen (1960)
- Strobach (1998)
- Wieland (1992)
- Yavetz (2015)

Physics I

Method: Angioni (2001); Bolton (1991); Bostock (1995); De Haas (2002); Turnbull (1976); Henry (2015)

Causes: Lang (1996): Scharle (2015); Bolton (2015)

Physics II

Nature and the natural: Fritsche (2010)

Four causes: Hennig (2009, 2010); Falcon (2015b); Hocutt (1974) and especially Annas (1982); Moravcsik (1975) prefers the more neutral term 'generative factor'.

Aristotelian teleology: Sauvé Meyer (1992); Gotthelf (1987) ; Furley (1996) ; Charles (1991); Johnson (2005) (file).

Physics III

Motion: Anagnostopoulos (2010); Marmodoro (2007); Verbeke (1971)

Physics IV

Place and Space: Lang (1998) ; Morison (2002), discussed in Mendell (2005)

Space: Sedley (2012); Hankinson (2012)

Time: Coope (2005); Harry (2015); Katayama (2011); Loughlin (2011); Roark (2011)

For issues pertaining to Aristotle's treatment of time, see Bostock (1980); Coope (2005)

Aristotle on the individuation of numbers: Gaukroger (1982); Annas (1976, 1988a)

Physics V-VI

Motions: Bostock (1991); Broadie (1983); Morison (2013); Murphy (2008); Rosen (2015)

On Aristotle and Zeno: Medlin (1963); Chappell (1962)

Instant of change: Kretzmann (1976); Sorabji (1976); cf also Sorabji (1983: 403–421) and Sorabji (1988)

Physics VII

Movings: Schofield (1991)Leunissen (2015d); Maso, Natali and Seel (2012)

Alteration: Maso, Natali and Seel (2012)

Physics VIII

First Motion: Blyth (2016); on its medieval reception: Puig (1990); Scharle (2008); Falcon (2015a)

Medieval commentaries

Simplicius, Themistus, Philoponus, Zimmermann (1968)

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The Aristotelian *Physics*

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The place of the *Physics* in the Aristotelian corpus

TBC

Chapter 1

Aristotelian science: why-questions and *archai*

1.1 What- and why-questions

1.1.1 The Socratic method

The so-called Socratic 'method', famously, is to ask, of a large number of phenomena x, what x is. In this way, the *Charmides* asks, "What is temperance [sôphrosunê]?", the *Laches* "What is courage [andreia]?", the *Euthyphro* "What is piety [hosiotês]?", and the *Meno* "What is virtue [aretê]?". In the appendix to his Stanford Encyclopedia Entry on analysis, Michael Beaney writes:

> On the whole, commentators agree that what Socrates is seeking are real rather than nominal definitions, definitions that specify the essential nature of the thing concerned rather than the properties by means of which we can recognise it or the meaning of the term used to designate it. But there has been more controversy over precisely what the presuppositions of the elenctic method are, and how to respond, in particular, to the charge that Socrates commits the so-called Socratic fallacy. Socrates appears to be committed to the principle that if one does not know what the F is, then one cannot know if F is truly predicable of anything whatever, in which case it seems pointless to try to discover what the F is by investigating examples of it via the elenctic method. (Beaney 2014: appendix I)

According to Beaney, the *Meno* may be read as presenting (or at least: working on) a solution to this problem. But what exactly *is* the problem? Beaney's anachronistic terminology, contrasting – in the style of John Locke (1632–1704) – 'nominal definitions' (definitions capturing the meaning of a word, as in "x is a bachelor $_{\text{def}} \leftrightarrow x$ is an unmarried [eligible, adult, human, (Western?), (heterosexual?), (etc.?)] male") with 'real definitions' (definition capturing 'what it is to be' a (particular or type of) thing) incorporates heavy theoretical machinery, as does the use of "essence".

The "Socratic Fallacy" is often said to consist in the reliance on the so-called "priority of definition" principle: if x fails to know what F-ness is, then x fails to know anything about F-ness (cf. Benson 1990: 19). If even to ask what F is requires knowing *something* about F (e.g. that we are interested in its nature), it follows the Socratic method is pointless.

More generally, we have here a version of the paradox of analysis, which may be simply put as follows: Trying to give some philosophical analysis of "p" (which may stand for any interesting philosophical claim, such as e.g. "any

state with an unequal income distribution is unjust")[1] requires finding some "q" that is at least materially equivalent with "p" (i.e.: true if "p" is; false if "p" is). If we suppose, however, that "p" *is* true, any true sentence "q" will do, which makes philosophy too easy. So something stronger is required. The paradox then lies in the apparent impossibility to come up with some strengthening of the biconditional (abreviated by "$\mathscr{O}\mathscr{P}$"), which makes the biconditional both non-trivial and a desirable outcome of philosophical inquiry:

(**An**) $\quad \mathscr{O}_{\surd}(p \leftrightarrow q)$

It seems that $\mathscr{O}_{\surd}$ must have at least the strength of metaphysical necessity: coinciding with "p" on its truth-value by 'cosmic coincidence', as it were, does not make "q" by itself an acceptable analysis. Requiring $\mathscr{O}_{\surd}$ to be as strong as "it is true in virtue of the meaning of some words contained in "p", on the other hand, is too strong, as it would make (**An**) knowable on the basis of our understanding of "p" alone and so entailed that philosophical analysis, while possible, is also pointless.

Perhaps for this reason, Alan Silverman, in another Stanford Encyclopedia entry, ties his otherwise quite similar description of the method of the early, "Socratic" dialogues to the 'mature' Platonic doctrine of the so-called 'self-predication' of forms as follows:

> At the heart of the Socratic elenchus is the 'What is X' question (where 'X' typically names an ethical property). The answers offered to these questions fail usually because they are too narrow or too wide. An answer is too narrow if it fails to include all cases. An answer is too wide if, while it includes all cases of, for instance, piety, it also includes other things, cases of justice or impiety. We can infer from these failed definitions a set of conditions Socrates places on an adequate answer to his 'What is X' questions. He is seeking an answer which picks out a Socratic Property, e.g., Piety, that is a universal such that: it is found whenever and wherever there is an instance of Piety; and it 'causes' or 'makes' the instance to be such as it is. Piety's power to make, e.g., Socrates, pious derives from Piety's itself being pious. Piety self-predicates: Piety is pious. Because it is pious, when Piety is present to/in Socrates, Piety causes Socrates to be pious. (Silverman 2014: sct. 1)

Independently of its intrinsic plausibility and potential theoretical benefits, the self-predicating character of Platonic forms is here said to be responsible for the fulfillment of a certain theoretical role, only quite imprecisely characterised by " 'causes' or 'makes' the instance to be such as it is". But what is it about Platonic forms that makes them suitable to play such a theoretical role? Against this backdrop, an important strand in Aristotelian theoretising may be understood as aiming at removing the 'scare quotes' from " 'causes' " and " 'makes' ".

1.1.2 Finding the *archai*

TO DO If I find the time, I'll add here something on the general project of the *Metaphysics*: finding the archai of things, which ground their ousiai, and on the different notions of "priority" in Aristotle (cf Peramatzis 2011).

According to Menn (2016: Iα3, p. 12), there are two families of views Aristotle opposes:

1. physicists: what is prior in time is prior in *ousia*
2. mathematicians, dialecticians: what is prior in *logos* (must be cited in the definition of another thing) is prior in *ousia*

There is another dimension of variability in our understanding of "*archē*": like "principle", it can stand both for what comes first in a theory of a subject matter and for what, according to a theory or by itself, comes first in the subject matter.

Quite generally, knowledge is knowledge (of) what something is.[2]

1. The expression "p" is thus used as what is called a "schematic letter", a typographic abbreviation of some assertoric sentence. If you want, you can replace it anywhere with a sentence of your choice. One example, for example, would be the following: "p" abbreviates "Sam knows that today is Monday"; "q" – the putative philosophical analysis – could then be: "Sam has the justified true belief that today is Monday".
2. Cf., e.g., Aristotle's specification of the function of tragedy as "learning, that is, figuring out what each thing is" (*Poet.* 1448b16–17).

1.1.3 Priority in Aristotle

TO BE DONE

1.2 Euthyphro and the direction of explanation

1.2.1 Euthyphro questions

Socrates' objection to Euthyphro's proposed definition of piety as what the gods love consists in pointing out that while

(**Eu**$_1$) The gods love x because x is pious.

is true,

(**Eu**$_2$) x is pious because the gods love x.

is false.

While this is an objection to a proposed definition (under the assumptions that (i) if it is not the definition of "piety" that gives us reasons to choose between (**Eu**$_1$) and (**Eu**$_2$), nothing else does, and (ii) that we have reasons to think that one, but also only one of them is true and that this itself should be explained), it also raises the more general problem we met earlier. In what terms are we to distinguish between the two directions of explanation in the supposedly true biconditional:

(**Eu**$_0$) x is pious iff the gods love x.

This question is related, but not identical with, the question how we are to explain the (supposed) difference in truth-value between (**Eu**$_1$) and (**Eu**$_2$), for this latter, but not the first, explicitly presupposes that there are no true instances of "p because p", the so-called " "because" of the exasperated parent".

Direction-of-explanation or 'who wears the trousers' questions are quite ubitquitous in philosophy. Perhaps they even are what philosophy *really* is about, though of course that itself is a philosophical question (and it is, moreover, unclear whether *it* can be put into Euthyphro form). It nonetheless is quite plausible, in my view, to take philosophy quite generally be concerned with *Euthyphro questions*; Euthyphro questions ask for a specific kind of explanation, they are requests to ϕ some x, where

- ϕ is some explanatory relation such as account for, make intelligible, analyse, make conceptual room for, provide for the possibility of,
- x is some very general phenomena of the word: (the nature of things belonging to) very general metaphysical categories [particulars, properties, substances, tropes, events, states of affairs, agents, God, space, time] and their (essential) relations, (the nature of) important classes of properties [modal, aesthetic, normative, moral, epistemic, mental, quantitative, colours, vectors,], (the nature of) a broad range of mental and bodily states [belief, desire, knowledge, expectation, hope, emotions, feelings, sensation, perception] or processes [most importantly, qualitative and substantial change]

In recent years, it has become fashionable to ask Euthyphro questions using the idiom of "grounding".[3] In the grounding literature, supposedly paradigm cases are often picked from the following list:

- the mental is grounded in the physical
- the normative is grounded in the non-normative
- the dispositional is grounded in the non-dispositional
- the legal is grounded in the social

3. Introductions to contemporary discussions of grounding are Clark and Liggins (2012), Correia and Schnieder (2012a), Trogdon (2013) , Hovda and Cross (2013), Bliss and Trogdon (2014) and Raven (2015).

- the moral is grounded in the non-moral
- the semantic is grounded in the social
- determinable properties are grounded in their determinates

Quite often, and without apparent awareness of heterogeneity, philosophers also say things such as:

- wholes are grounded in their parts
- sets are grounded in their members
- holes are grounded in their hosts (the things *in* which they are holes)

1.2.2 A typology of Euthyphronic inquiry

TO DO: find a number of notable features Euthyphro questions have in common; organise them in a somewhat elucidating way.

1.2.3 Kinds and senses of "because"

It is perhaps useful to note that merely drawing a distinction between different senses / types / kinds of "because" does not, by itself at least, provide an answer. The Thomistic answer, e.g., distinguishes two different senses of "because" – "the pious action is pious because the Gods love it" specifies the *ratio essendi*, while "the Gods love the pious action because it is pious" talks to the *ratio agendi* – and so just supplants one incompatibility with another: "But a motivational 'because' running in one direction is incompatible with a constitutional 'because' running in the other direction, so Plato is right to see the alternatives as competing." (van Cleve 1994: 581, fn. 9)

MORE HAS TO BE ADDED

1.3 Platonism and Aristotelianism

In this section, I want to paint, in rather brush strokes, a (to me, at least) plausible picture of how Aristotle's approach to metaphysics fit into (something like) the Platonic framework, and to highlight the 'ecumenical' theoretical role the so-called "doctrine of the four causes" plays in this picture.

1.3.1 Physical mathematics vs. mathematical physics

Plato's conception of mathematics may, with some qualifications, be called 'Pythagorean': mathematics describes an eternal and unchanging, entirely formal but self-subsistent structure of entities that are not dependent on, nor grounded in, nor abstracted from the objects of empirical knowledge (if we have such knowledge at all).

Aristotle has an entirely different conception: he finds mathematical structures within the empirical world, not just mirroring but also grounding its law-governed dynamics and making it intelligible. The way mathematical structures are present 'in' the empirical world is the explanandum of the form/matter distinction. While matters are certainly very complicated, forms are certainly not 'in' the things they are forms of in a way that would make them separable.[4] Form/matter compounds should not be thought of as just thereby (i.e.: just in virtue of being compounds) complex, i.e. not as composites of two individually identifiable components – their matter and their form – but as matter-that-is-formed, where the form is not a what-is (by itself), but a special type of a how-something (i.e. the matter)-is, namely the what-it-is-(for-the-matter-)to-be-the-kind-of-thing-this-is. While this contrasts 'immanent' Aristotelian forms with 'transcendent' Platonic ideas, it leaves open the type of immanence, inter alia the question whether Aristotelian forms are (general) universals or (particular) tropes.[5]

4. In fact, Aristotle takes separability as a characteristic of *Platonic* forms and argues against it, and hence against them.

5. Properties, if they exist at all, are entirely 'qualitative' entities that can be 'exemplified' (= had) and the exemplification of which plays at least one of three theoretical roles: grounding resemblance, 'making for' qualitative identity, serve as truthmakers for quality attributions. Universalists conceive of them as universal, i.e. numerically identical across different exemplifications, while tropists take them to be particulars, at best exactly similar but never numerically identical.

Aristotle distinguishes four types of 'causes' and criticises Plato for focussing solely on one – the formal (type of) cause. When a builder builds a house out of bricks according to a plan, we can ask four (types of) why-questions – all variants, with different emphasis, of the question "why did the house come about?":[6]

efficient cause how does the house come about? by the initiation of the (activity or process of) building, rather than, e.g., by the initiation of a process of growing.

material cause out of what does the house come about? out of the bricks that then constitute it, rather than, e.g., some wooden planks.

formal cause what makes it a house that comes about? a plan, account, definition of what a house is, rather than, e.g., a plan, account, definition of what a church is.

final cause for what does a house come about? to provide shelter, rather than, e.g., to embellish the landscape.

Even at this high level of abstraction, however, the account has to be made more complicated than this:

- The theory of efficient causality has to take into account the distinction between potentiality and actuality, which applies to (efficient) causes and effects symmetrically: in the same way as the (process of) building actualises a way for the bricks to be – a way they previously were only potentially –, it also actualises a way for the builder to be (being such as having built a house) she antecedently was only potentially.
- The theory of material causation has to take into account the relativity of the matter/form distinction: while the bricks are matter-for the house, they may themselves have been formed out of mud, i.e. be themselves formed matter. Whether the distinction 'bottoms out', ie. whether there is ultimate, or 'prime' matter, is a disputed question.
- The theory of formal causation has to take into account that one and the same form explains why the house is a house and why the house-builder is a house-builder, i.e. the 'transmission' and resultant commonality of the form along relations of efficient causality (the problem is hairiest with respect to the conception of perception as 'uptake of form without matter').
- The theory of final causation has to take into account that what it is for a house to be (to be a house) is both what explains why the builder acts in the way she does *and* determines her success in doing so. Among other things, it has to explain why a three-legged dog is possible, being both a dog and a less-than-optimal dog, and why a house is for providing shelter and may still fail to do so (perhaps because it is incompetently built).

An important point emerges, even temporarily forgetting about such necessary qualifications: Aristotle thinks of these four causes (or perhaps better: reasons, explanations, grounds, process-aspects?) not on the model that contemporary theorists use when they talk, e.g., about causal overdetermination (different causes being individually sufficient for one and the same effect) or the 'causal closure' of the physical (that effects of a certain – physical – type can only have causes of that same type). Rather, it is an in principle open-ended taxonomy for talking about the dynamics of things in the broadest sense, including not just qualitative change, but motion, qualitative hetereogeneity, coming into being and ceasing to exist.

1.3.2 Ideas & participation vs. form and matter

I find it an attractive interpretative hypothesis that the complexity of Aristotle's system is motivated, at least in part, by his perceiving a need to make certain distinctions in order to avoid the roughly 'Parmenidean' account Plato gives of fundamental reality. One major problem of such an account, in my own words, can be put as follows: it is not possible that the changing reality (or at least the changing of reality) is only apparent because in order for us to be mislead in this way (to falsely think reality changes) we ourselves (or the appearances we have) must be assumed to change. Immutabilism is metaphysically possible, but dialectically self-undermining: if it were true, we could never take it to be false; but we do; hence it is false.[7]

Perhaps it is this consideration that leads Aristotle to give so much critical attention to the relation Plato postulates between the world of ideas and the empiricial world. A beautiful rose, for Plato, is beautiful in virtue of participating

6. Perhaps "why *did* the house come about?" can be heard as a question about the efficient cause, where "why did the house *come about*?" would ask for the material, "why did *the house* come about?" for the formal and "why did the house come *about*?" for the final cause.

7. It is also quite difficult to see how anyone could ever become *convinced* of immutabilism, if she was not so convinced already. Cf. p. 28 below.

/ partaking in the idea BEAUTY (or perhaps: the idea of beauty; or even: the idea of beautiful things). Aristotle objects (i) that the relation of participation is mysterious, (ii) that it does not explain what it was introduced to explain and (iii) that it leads to a vicious regress. It is mysterious because it is external, i.e. not uniquely determined by how its relata are, but depending on further factors 'outside' of them. It is explanatorily impotent because it does not show *how* BEAUTY makes the rose beautiful, but only states that it does: not only does the relation just by itself provide no basis to distinguish different ideas, nor (what could come to be the same thing) does it explain their potency in making things, e.g., beautiful. Properties are what grounds, and thereby explains, the differences between similarities-in-respect (e.g. the difference in the way two red things and two round things are each one similar to the other). This is why an explanation in terms of them being related to different forms just pushes the explanatory need up the relation: we then need an explanation of the difference between the forms, which is a difference in quality itself (and, if forms are self-predicative, even itself a qualitative difference). The participation relation by itself also does not seem to be of the right kind to provide such an explanation: the mere existence of a further thing will not 'tie' the rose appropriately to the idea; we need the relation 'as relating', or 'insofar as it relates them', but this invites a further why-question (why does it relate the rose to the idea?) which has not yet received an answer.

Third and most importantly, postulating (the relation of) participation for explanatory purposes leads to vicious regresses, commonly called 'third man' problems. One of them may perhaps be put as follows: A minimal requirement for BEAUTY to bestow, in some sense, beauty on the rose is for it to be itself beautiful (perhaps this is an instance of "nothing can come from nothing"?). The commonality between the beautiful rose and beautiful BEAUTY is then part of what explains that the rose is beautiful (or, perhaps better: what it is for the rose to be beautiful). This commonality, however, is in itself in need of explanation, for it is of the same kind as the commonality between two beautiful roses – which to explain BEAUTY was invoked in the first instance. No other way of explaining the commonality between the rose and BEAUTY is available, however, than in terms of yet another super-form SUPER-BEAUTY, itself beautiful, in which both the rose and BEAUTY participate. Unless and until we have explained this super-form (and all the infinitely many on top of it), we have not explained the initial datum, which is just to say that Plato's participation account of quality-possession has no explanatory power at all.

Plato, of course, had his reasons to introduce ideas. Only ideas, he might say, explain (i) how we can have knowledge of things (the problem being particularly pressing, but not limited to, a priori knowledge), (ii) why things are not just coincidentially how we take them to be, but really do exhibit the patterns and structures we observe them to have with some robustness or 'necessity', and finally (iii) that there are, or at least could be, eternal and unchanging things. To the extent that the interpretative hypothesis sketched above is on the right track, we may expect Aristotle to address these problems.

1.3.3 Mere appearance vs. the reality of change

Plato is an anti-realist or at least a reductionist about change: change is, or even must be, wholly explainable in terms of unchanging things and is, at least to this extent, only apparent. Aristotle's world, on the contrary, is fundamentally dynamic: he takes the actuality of qualitative change (from red to non-red), intensification (from slower to faster), growth (from thinner to fatter) and of substantial change (coming to be, ceasing to be) as a datum; on the other hand, he also accepts "ex nihil nihilo fit": all change is change of something, something happening to something else, i.e. in all change, something must 'underlie'.

His hylomorphic account of change in terms of an underlying matter changing its form between opposites aspires to reconcile these opposing tendencies by providing a middle way between (i) the atomists who have unchanging things and cannot explain how change emerges from their interaction because they falsely suppose that all change is qualitative and (ii) the Platonists who admit only opposites, and nothing underlying and hence are committed to construe all change as either extrinsic or existential (and hence, given further Parmenidean assumptions, impossible). We are thus drawn into different directions: to satisfy the incompatibility condition on change, we need a succession of two different things; to satisfy the proper subject condition, we need an unchanging thing. If we have only one of them, we do not have change. But do we have change if we have both? We call the first "form",

the latter "matter". Crucial question: in what sense does changing form + unchanging matter result in changing compound? Two subquestions:

(i) what are the relations between (i-a) form and the compound, (i-b) matter and the compound, (i-c) form and matter? they must be of the type that underwrites our epistemic right to infer what happens with the compound from (and, more ambitiously, explain it by) what happens with matter and form;
(ii) in what sense is the situation asymmetric enough to ascribe change to the compound? why do we privilege the change in the form over the constancy in the matter?

"Parthood" as an answer to the first two questions of (i) has problems with (ii). This has to do with it's not directly answering (i-c), ie. it's not giving us a real, direct, relation between the form and the matter. But if the form is not part of compound, in what way is it its form?

Aristotelian dynamics operates with a crucial, but unfortunately quite opaque, distinction between two modes of being: potentiality, power or ground of possibility – *dunamis* – on the one side, and actuality, realisation or reality – *energeia* – on the other. Though the distinction is supposed to have a much more general application (and its difficulty is partly due to its very high degree of generality), perhaps the clearest case of the dunamis/energeia distinction is the relation between a capacity for change and the changes to which it gives rise. All change is due to a capacity for change, a dunamis: what there is constrains what must have been possible. Conversely, some dunamis also explains the energeia it is a dunamis-for: what can be constrains what there is. Even in this perhaps simplest case, however, the distinction is *not* the one we are perhaps more familiar with between a disposition (dispositional property, 'potentiality', 'power') like *fragility* and its manifestation, the shattering of a particular glass. Dunamis and energeia are correlative, and the dunamis by itself explains or grounds its actualisation. Neither does Aristotle have a simple counterfactual analysis: the dunamis is not what a thing would be under such-and-such circumstances, but a way the thing is in the here and now.[8]

Aristotle's realism about change is also a realism about our perception of it: when we start to see the redness of the rose, we become related to redness – in a similar, though different way in which the rose becomes related to redness when it itself becomes red. Cashing out the sense in which redness figures in its perceiver not just apparently, but really, is in my view one of the hardest problems of Aristotle exegesis.

8. As with the matter/form distinction, the issue is further complicated by the fact that this distinction too is relative: something may, e.g., have a dunamis to have another dunamis.

Chapter 2

Physics I: Beginnings and Causes

2.1 The argumentative strategy of *Physics* I

In his introduction to the *Clarendon Aristotle Series* edition of the first two books, Charlton (1992) gives the following overview of what is, according to him, a dialectical investigation of the things that are subject to change (as such, i.e. insofar as they are subject to change). According to Charlton, the guiding question of *Physics* I is: What is there / what is in the world? (*ti to on*?), more specifically: what must there be if there is coming to be, passing away and alteration? It is as a response to this question, that the form / matter distinction is introduced:

I.1 intro
I.2+3 there is becoming (against the Eleatic monists)
I.4 review of the Presocratics
I.5 among the principles of any physical thing are a pair of opposites
I.6 among the principles of any physical thing is a third thing
I.7 an analysis of becoming: if physical things have a form and are constituted by a underlying thing, we can accept the results both of I.5 and I.6
I.8+9 this analysis explains the mistakes and the difficulties of the alternative theories

More specifically, we have the following dialectic (my interpretation):

I.1 When we want to know a thing, we are interested in a thing's "primary causes" (*archai*), its "principles" (*aitia*) and its "elements" (*stoicheia*). We should start with "what is clearer and more knowable to us" and proceed, by analysis, to "what is more knowable and clear by nature". This transition is from the compound to the elements and from the universal to the particular.

I.2 There are four possibilities:

1. There is just one primary cause (*arche*) and it does not change [Parmenides, Melissus].
2. There is just one primary cause and it does change ['physicists', *physikoi*].
3. There are a finite number of primary causes.
4. There are an infinite number of primary causes.

With (1), this one unchanging primary cause cannot be a quality or a quantity, but must be a thing (*ousia*); but then it cannot have any qualities and cannot have any parts.

I.3 Ad (1). If there is just one primary cause, nothing can be predicated of it, and it cannot even be said to be. This is absurd.

I.4 Ad (2). To explain the change in an underlying one, the physicists need notions of 'mixture' and of 'separation'. But these notions only apply to things that have parts, i.e. are complex. But if there is just one primary cause, it cannot have parts.

I.5 Ad (3). If primary causes are finite in number and are to explain change, we must assume that at least some of them come in pairs of opposites.

[Ad (4): why assume there is an infinite number if we can 'get by' with a finite number?]

I.6 If there were just two primary causes, they would have to be opposites. But opposites must qualify something: they are opposite ways to be, i.e. presuppose something which is a certain way and also is another, opposite, way.

I.7 Aristotle presents his own account: in one sense, there are two principles (form and matter), in another sense there are three (for the matter is "two in account", and the form is "one in account").

I.8 That the matter is "two in account" and that there is change between opposites, i.e. from what is not towards what is (e.g. from cold, which is a privation, to hot) explains how we must qualify "ex nihilo nihil fit": the lack of hot, out of which something becomes hot, is something which is not, but it is also not a constituent.

I.9 The Platonists rightly see that change is between opposites, but because they do not have an underlying thing, have to say that they 'yearn for their own destruction', i.e. have an inner dynamic principle.

2.1.1 "Better known by nature"

That the aim of science is to uncover what is "more intelligible by nature" is first stated in the *Posterior Analytics* (*APo* 71b33–72a5). Whatever else it is, the epistemic characterisation serves as an adequacy criterion for *scientific* arguments: they not only have to be valid syllogisms, but their premisses have to be better known-by-nature than their conclusions. Science (*episteme*) is said to be characterised by this aim: it not only reports the facts but *explains* them by displaying their priority relations (*APo.* 78a22–28). The criterion also restricts the proper objects of science: Only what is necessary can be known, properly speaking. whatever is known without qualification cannot be otherwise (*APo.* 71b9–16).

This characterisation recurs at the beginning of the *Physics*:

πέφυκε δὲ ἐκ τῶν γνωριμωτέρων ἡμῖν ἡ ὁδὸς καὶ σαφεστέρων ἐπὶ τὰ σαφέστερα τῇ φύσει καὶ γνωριμώτερα· οὐ γὰρ ταὐτὰ ἡμῖν τε γνώριμα καὶ ἁπλῶς. (184a16–18)	The natural way of doing this is to start from the things which are more knowable and clear to us and proceed towards those which are clearer and more knowable by nature; for the same things are not knowable relatively to us and knowable without qualification. (Aristotle 2014: 699)	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. (Aristotle 1992: 1)

Somewhat ironically, Aristotle thus opens his treatise on natural things by a claim about what is natural to us (ἡ ὁδὸς . . . πέφυκε): to proceed from what is more knowable (γνωριμωτέρον) and clearer to us to the things that are so by nature (φύσει) or *simpliciter* (ἁπλῶς).

2.1.2 Against monism

Physics I.2 and I.3 present an argument (or two arguments) against Eleatic monism. Aristotle starts by noting that being is said in many ways (πολλαχῶς λέγεται τὸ ὄν: that what it is for a thing / *ousia* like a dog to be is one thing, while that what it is for a quality like pale to be is another thing) and asks in what way the Eleatics want their claim that everything *is* of one type to be understood: are they claiming that there are only things (like dogs), or only qualities (like pale), or only quantities (like)? They must mean the first, because it is impossible that there be only qualities and nothing having them:

οὐθὲν γὰρ τῶν ἄλλων χωριστόν ἐστι παρὰ τὴν οὐσίαν· πάντα γὰρ καθ' ὑποκειμένου λέγεται τῆς οὐσίας. (185a27-32)	For none of the others can exist independently except substance; for everything is predicated of substance as subject. (Aristotle 2014: 702)	Nothing can exist separately except a reality; everything else is said of a reality as underlying thing. (Aristotle 1992: 3)

In what sense do they mean their claim that all things are one – as parts identical to one whole, as indivisible or as having the same essence? It cannot be the first, because the whole is a whole only if it has several parts and these

cannot be all identical to it. It cannot be the second because what is indivisible is point-sized. If they mean the third, they claim – like Heraclitus – that there are true contradictions, that something e.g. may be hot and cold.

Aristotle's discussion of a variant of this view by the "more recent of the ancient thinkers" is very interesting:

διὸ οἱ μὲν τὸ ἐστὶν ἀφεῖλον, ὥσπερ Λυκόφρων, οἱ δὲ τὴν λέξιν μετερρύθμιζον, ὅτι ὁ ἄνθρωπος οὐ λευκός ἐστιν ἀλλὰ λελεύκωται, οὐδὲ βαδίζων ἐστὶν ἀλλὰ βαδίζει, ἵνα μή ποτε τὸ ἐστὶ προσάπτοντες πολλὰ εἶναι ποιῶσι τὸ ἕν, ὡς μοναχῶς λεγομένου τοῦ ἑνὸς ἢ τοῦ ὄντος. πολλὰ δὲ τὰ ὄντα ἢ λόγῳ (οἷον ἄλλο τὸ λευκῷ εἶναι καὶ μουσικῷ, τὸ δ' αὐτὸ ἄμφω· πολλὰ ἄρα τὸ ἕν) ἢ διαιρέσει, ὥσπερ τὸ ὅλον καὶ τὰ μέρη. ἐνταῦθα (186a.) δὲ ἤδη ἠπόρουν, καὶ ὡμολόγουν τὸ ἓν πολλὰ εἶναι—ὥσπερ οὐκ ἐνδεχόμενον ταὐτὸν ἕν τε καὶ πολλὰ εἶναι, μὴ τἀντικείμενα δέ· ἔστι γὰρ τὸ ἓν καὶ δυνάμει καὶ ἐντελεχείᾳ. (185b27-186a4)

So some, like Lycophron, were led to omit 'is', others to change the mode of expression and say 'the man has been whitened' instead of 'is white', and 'walks' instead of 'is walking', for fear that if they added the word 'is' they should be making the one to be many – as if 'one' and 'is' were always used in one and the same way. What is may be many either in definition (for example to be white is one thing, to be musical another, yet the same thing may be both, so the one is many) or by division, as the whole and its parts. On this point, indeed, they were already getting into difficulties and admitted that the one was many – as if there was any difficulty about the same thing being both one and many, provided that these are not opposites; for what is one may be either potentially one or actually one. (Aristotle 2014: 704)

Some, like Lycophron, did away with the word 'is'; others sought to remodel the language, and replace 'That man is pale' 'That man is walking', by 'That man pales' 'That man walks', for fear that by inserting 'is' they would render the one many – as if things were said to be or be one in only one way. Things, however, are many, either in account (as the being of pale is different from the being of a musician, though the same thing may be both: so the one is many), or by division, like the parts of a whole. At this point they got stuck, and began to admit that the one was many; as if it were not possible for the same thing to be both one and many, so long as the two are not opposed: a thing can be one in possibility and in actuality. (Aristotle 1992: 3)

Lycophron's worry, as reported by Aristotle, is that the copula would separate the subject and the predicable of the predication and that this was incompatible with its truth, as its truth would require them to be one.[1]

I.3 reinforces this criticism by construing Parmenides as denying that being is said in many ways, i.e. holding that being – what it is to be – is unitary, that there is just one way to be (this does not, as Aristotle points out, rule out that there are many things, so yields only a weak form of monism). The problem with even this weak position that Aristotle points out is that *being* certainly is, but that it has another way of being than that to which it applies. The reasoning may perhaps be reconstructed as follows: if *being* (i.e. the property of being) is unitary and is, then it is the only thing that is; but then it cannot be a property of anything, for if it were a property of some *x*, then it would be different from *x*, and because it is the only thing there is, *x* would not exist.

2.1.3 Against the physicists

In I.4 and I.5, Aristotle considers two types of physicists: the first postulating intrinsically uniform matter, the second postulating intrinsically multiform matter; the first reducing qualitative change to existential change, the second existential change to qualitative change. In I.4, he argues agains the second (Anaximander, Empedocles, Anaxagoras) that they cannot allow for alteration of their elements (for their qualitative characteristics is what makes matter multiform, and matter cannot be multiform only contingently), so that everything there is is characterised by a fixed propertion of different kinds of matter. This, however, is impossible, because some thing have a minimal size and may still undergo change (just not qualitative change, but existential change): such change can then *not* be explained by their losing any of the elements that make it up.

The argument against the physicists postulating uniform matter (Thales, Anaximenes, Heraclitus) can perhaps be inferred on the basis of I.5. It is that they have the opposite problem: their only principle of change is a the opposing pair of densification and rarefaction; these produce the things as they are. Hence for them all qualitative change is a production of something new. But this new thing which is, e.g., hot is not a result of a change that is *from* the non-hot, for it is wrong to say that *it* was not hot before.

1. Aquinas elaborates on this, making Lycophron first propose "homo albus", and then proceed to "homo albatur", ascribing to him the view that in this latter sense "per hoc quod est albari, non intelligitur res aliqua, […] sed quaedam subiecti transmutatio" (Commentaria in octo libros Physicorum liber I lectio IV, §§26, Leoninum edition). "Homo albatur" would thus, for Aquinas' Lycophron, not properly speaking be a predication, but would perhaps be a 'feature-placing' sentence in Strawson's sense.

2.2 The problem of change

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2.2.1 Variation and constancy in change

According to Haslanger (2003), the puzzle of change arises from the inconsistency of the following five claims:

1. Persistence condition: Objects persist trough change.
2. Incompatibility condition: The properties involved in a change are incompatible.
3. Law of non-contradiction: Nothing can have incompatible properties, i.e. nothing can be both P and not P.
4. Identity condition: if an object persists trough change, then the object existing before change is one and the same object as the one existing after the change; that is, the original object continues to exist through change.
5. Proper subject condition: The object undergoing change is itself the proper subject of the properties involved in change.

Because there is change (1), objects persist (4) and the properties which they (5) have are incompatible (2) which is impossible (3).

The two main families of 'solutions' to the problem of change replace one of the blue lines above by a red one, denying either the incompatibility of the properties involved (2) or the numerical identity of the persisting object (4). The first view – endurantism – typically time-indexes the property: the thing is then said to 'change' from having F-at-t_1 to lacking F-at-t_2. This turns line 1 red: the two properties, *having* F*-at-*t_1 and *having* F*-at-*t_2 are not the same – what is had before the change is not what is lacked after it.[2] The second view either postulates temporal parts and attributes the properties to their whole (perdurantism: a is said to 'change' by having a temporal part that is F at t_1 and another temporal part that is not F at t_2) or postulates temporal parts and attributes the properties to them (exdurantism: a is said to 'change' by there being short-lived things a-at-t_1 and a-at-t_2 that are and are not F respectively). The problem with these solutions that none of them leaves room for change – which is why the occurrences of this word above are in scare quotes.

Aristotle has a different, more subtle and in my view also more plausible account of change: the change from the a-that-is-F to the a-that-is-not-F is explained in terms of them having two aspects, one material one in which they are one and another formal one in which they are not one. We discuss first the first, then the second aspect of this view.

2.2.2 Hylomorphic change

It is a curious fact that when reviewing the theories of his predecessors in fundamental physics, Aristotle is more interested in the *number* of principles they 'used' to 'generate' things than in their *nature*. He criticises the Eleatics, who 'use' just one (chapters I.2 and I.4) and Anaxagoras, who 'used' infinitely many (I.4), concludes (I.5) that one thing they got right is to use opposites (*enantia*) and argues that one pair of opposites will suffice (I.6). But which one? As Bostock (1995: 3–4) notes, Aristotle shows no interest in the question, but rather offers, in I.7, a *typology* of opposites, in terms of "form" (*eidos*) and "privation" (*sterēsis*), which must be 'added' to the underlying thing (*hupokeimenon*) to account for change. While form and privation are not, in general, opposites,[3], all opposites fall within the form/privation dichotomy. All opposites need to be predicated of some subject which, according to the *Categories* must always (ultimately) be a substance, and such a predication either predicates the having or the lacking of some form.

2. Or rather: if it is lacked after it, it is not because there was a change – *having* F*-at-*t_1 is also lacked, at t_2, by a thing that remained F throughout.

3. Quantitative properties and their relative lacks are (e.g. hot and cold), but properties in the category of substance are not (e.g. a tree, a house, a statue, vinegar), because substances have no opposites (cf. e.g. *Cat.* 3b24-32).

Opposites (*enantia*) are principles (i.e. irreducible) because they come *out of*, but not *from* each other: the hot comes out of the cold, but not from the cold, because the cold does not have in itself a tendency to annihilate itself. In I.5, Aristotle argues that this is true of all change: if something becomes F, it comes out of being not-F; if it ceases to be F, it comes out of being F; if it becomes a house, it was not a house before; if it ceases to be a house, it was a house before.

After having established in I.5 that change needs diversity, i.e. a pair of opposites, Aristoteles argues in I.6 that

οὐθενὸς γὰρ ὁρῶμεν τῶν ὄντων οὐσίαν τἀναντία, τὴν δ' ἀρχὴν οὐ καθ' ὑποκειμένου δεῖ λέγεσθαί τινος. (189a29-30)	[w]e do not find that the contraries constitute the substance of any thing[; b]ut what is a first principle ought not to be predicated of any subject. (Aristotle 2014: 716)	[w]e never see opposites serving as the reality of anything, and yet a principle ought not to be something said of some underlying thing. (Aristotle 1992: 13)

Because opposites are predicables, they presuppose an *ousia* ("reality", "substance") as their *hupokeimenon*. This is a clear echo of the *Categories*, where Aristotle distinguishes ten categories of things, according to the grammatical type of the words that represent them in sentences.

Aquinas finds another echo of the *Categories* in this passage:

Sed si ponamus sola contraria esse principia, oportet principium esse aliquod accidens de subiecto dictum: quia nullius rei substantia est contraria alteri, sed contrarietas solum est inter accidentia. (Commentaria in octo libros Physicorum liber I lectio XI, §91, Leoninum edition)	…if we hold that only the contraries are principles, it is necessary that the principles be an accident predicated of a subject. For no substance is the contrary of something else. (St. Thomas Aquinas 1999: ad loc.)

The two reasons are perhaps connected: they are if only predicables can be opposite to anything. This would be so if to be 'opposite' already presupposes a dimension of comparison, if comparison is possible with respect to how things are and if, finally, to say how things are *is* to predicate something of them.

In the quote above (189a29-30), Aristotle construes 'predication' (i.e.: exemplification, the having of a property) as a relation of ontological dependence: what is an 'opposite', i.e. a dimensional characteristic (such as *being hot* and *being cold* on the temperatur scale and *being a house* and *not being a house* along the temporal dimension of house-construction), is *placing* something else on that dimension: that something else is the thing it qualifies. Opposites are ways to be and every way to be must be a way *for some thing* to be. Things that something else to be the things they are are dependent on such other things for their essence and identity; they are not self-standing entities and cannot be principles.

Aristotle briefly considers the possibility that there might be more than one pair of opposites, more than one way of things being different from each other than by either having or lacking qualitative characteristics. The argument he gives to rule out this possibility is very interesting:

ἅμα δὲ καὶ ἀδύνατον πλείους εἶναι ἐναντιώσεις τὰς πρώτας. ἡ γὰρ οὐσία ἕν τι γένος ἐστὶ τοῦ ὄντος, ὥστε τῷ πρότερον καὶ ὕστερον διοίσουσιν ἀλλήλων αἱ ἀρχαὶ μόνον, ἀλλ' οὐ τῷ γένει· ἀεὶ γὰρ ἐν ἑνὶ γένει μία ἐναντίωσις ἔστιν, πᾶσαί τε αἱ ἐναντιώσεις ἀνάγεσθαι δοκοῦσιν εἰς μίαν. (189b22-27)	Moreover, it is impossible that there should be more than one *primary* contrariety. For substance is a single genus of being, so that the principles can differ only as prior and posterior, *not* in genus; for in a single genus there is always a single contrariety, all the other contrarieties in it being held to be reducible to one. (Aristotle 2014: 718)	Moreover, there cannot be more than one primary opposition. Reality is a single kind of thing, so that the principles can differ only in being prior or posterior to one another, and not in kind. In any one kind there is always one opposition, and all oppositions seem to reduce to one. (Aristotle 1992: 14)

"*ousia*" is here to be understood as "thing", whatever fundamentally is, so that its genus encompasses absolutely everything.[4]

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4. It is an interesting fact that Aristotle is both a pluralist about modes of being ("being is spoken of in many ways"…) and at the same time allows for absolutely unrestricted quantification, over the genus of *ousia*.

Even though we have, both in (2) and (3), something new coming to be (a musician in the first case, a musical man in the second), the change of Socrates' learning music as a whole is a qualitative, not a substantial change: this is because the underlying thing remains the same (cf. p. 16 below):

Ἐν δὲ τούτοις ἄν τι ὑπομένῃ πάθος τὸ αὐτὸ ἐναντιώσεως ἐν τῷ γενομένῳ καὶ τῷ φθαρέντι, οἷον ὅταν ἐξ ἀέρος ὕδωρ, εἰ ἄμφω διαφανῆ ἢ ψυχρά, οὐ δεῖ τούτου θάτερον πάθος εἶναι εἰς ὃ μεταβάλλει. Εἰ δὲ μή, ἔσται ἀλλοίωσις, οἷον ὁ μουσικὸς ἄνθρωπος ἐφθάρη, ἄνθρωπος δ' ἄμουσος ἐγένετο, ὁ δ' ἄνθρωπος ὑπομένει τὸ αὐτό. Εἰ μὲν οὖν τούτου μὴ πάθος ἦν καθ' αὑτό ἡ μουσικὴ καὶ ἡ ἀμουσία, τοῦ μὲν γένεσις ἦν ἄν, τοῦ δὲ φθορά· διὸ ἀνθρώπου μὲν ταῦτα πάθη, ἀνθρώπου δὲ μουσικοῦ καὶ ἀνθρώπου ἀμούσου γένεσις καὶ φθορά· νῦν δὲ πάθος τοῦτο τοῦ ὑπομένοντος. Διὸ ἀλλοίωσις τὰ τοιαῦτα. (319b21-31)

If, however, in such cases, any property (being one of a pair of contraries) persists, in the thing that has come-to-be, the same as it was in the thing which has passed-away – if, e.g., when water comes-to-be out of air, both are transparent or cold – the *second* thing, into which the *first* changes, must not be a property of this. Otherwise the change will be alteration. Suppose, e.g., that *the musical man* passed-away and *an unmusical man* came-to-be, and that *the man* persists as something identical. Now, if musicalness (and unmusicalness) had not been in itself a property of the man, these changes would have been a coming-to-be of unmusicalness and a passing-away of musicalness; but in fact a property of the persistent thing. (Hence these are properties of the man, and of *musical man* and *unmusical man*, there is a passing-away and a coming-to-be.) Consequently such changes are alteration. (Aristotle 2014: 1144–1145)

If some affection in that which passes out of existence remains in that which comes into existence, as transparent and cold do when air turns to water, the thing which the change is a change to must not be an affection of this. If it is, the change will be an alteration. Thus suppose a man who knows music ceases to exist, and a man who is ignorant of music comes into being: the man remains the same. Now if knowledge and ignorance of music were not affections of this, it would be a case of coming to be and passing away […] but as they are, it is a case of alteration.

It is because the end-product, the *terminus ad quem*, of the change (musical man) is not describable except by reference to its starting point, the *terminus a quo* (man, i.e. unmusical man), and thus "parasitic on, called real because of its relation to, anything which remains throught the change" (Charlton 1992: 75), that the change is an alteration.

It is to substantial change that Aristotle turns next. Substantial change occurs when something comes to be *something*, a thing (*ousia*); but whatever the process (change of shape, addition, substraction, composition or alteration), something undergoes the process and thus must enter into it.

"ARISTOTLE-FORMS.TEX"

This analysis, according to Aristotle, applies to all change: everything that comes to be is composite and composed of and coming out of the underlying thing (*hupokeimenon*) and the form (*morphē*), in the way *musical man* is composed of *man* and *knowing music* and its analysis (*dialusis*) is complex, in terms of these two. This allows for all three answers to the question how many principles of change there are:

one, because the thing that changes (that comes to be), *musical man*, is numerically one with *amusical man*;
two, because the thing that changes is two in form (*eidei duo*): the musical man is, essentially, the underlying thing, *man*, but also, by concurrence (i.e. accidentally), the lack (*steresis*): *amusical*.
three, because in addition to these two, we have the form (*knowledge of music* which is one, and which also comes to be.

2.2.3 The 'Aufhebung' of the predecessors

"ARISTOTLE-FORMS.TEX"

The Platonists, by contrast, attribute the principle of change to the form and take their dual matter (which Aristotle takes to be the space/receptacle of the *Timaeus*) to be uniformly non-existent.[5] Because they thus think that all change is from what-is-not, they cannot explain why the forms would undergo or initiate a change: their forms are both absolute and unchanging, after all.

5. Or, at least: part of what is not. Charlton mentions that Cherniss (1944: 92) points out that Aristotle says in *Met.* N 1089a20-21 that by "what is not" Plato meant what is false, or, at least, what is negative described (as not earth, not air, not fire, nor water, *Tim.* 51a5).

(*Physics* I.9 is one of the rare places where we find some discussion of what some think is a doctrine of Plato's different from the theory of ideas: the theory of principles or the 'unwritten doctrine'. It seems that Aristotle is discussing a passage from the *Timaios* (uploaded). The bits at the end of the October 9 session that were cut off and not recorded consisted of some jokes I made about the receptacle story (and its sexism).)

2.3 The puzzle of matter

In Aristotle's preliminary analysis of change, talk of the *hupokeimenon* of change plays a double role: it may designate that of which we say that it changed, the logical subject of change, always a substance; and also that within which the change takes place, which typically is not a substance but matter, *hule*. That it is both is required by the fact that the *hupokeimenon* is both what is constant during the change and what comes to be, though it is not the only thing that comes to be – what comes to be is something which is both a form and matter.

2.3.1 Matter as the subiectum / hupokeimenon of change

The hylomorphic account of change is in terms of an underlying matter changing its form between opposites: the man is underlying, only potentially knowing music; the form changes from ignorant of music (or: that which is ignorant of music) to knowing music (or: that which knows music); the thing that comes to be is knowing music man, a composite of man and knowing music.

Charlton (1992: 73) says that "Aristotle's matter-form distinction is primarily […] a distinction between constituent and thing constituted, between what a thing is made of and what that of which it is made makes or constitutes". The third thing – matter – is "not a third factor over and above the opposites; it is the same thing as one of the opposites, viz. that from which the change takes place, but under a different description." (Charlton 1992: 73) – they are one in number but two in logos (190a15-16).

Shields 2015 reads I.7-8 as an "argument for matter and form":

> Encapsulating Aristotle's discussions of change in Physics i 7 and 8, and putting the matter more crisply than he himself does, we have the following simple argument for matter and form: (1) a necessary condition of there being change is the existence of matter and form; (2) there is change; hence (3) there are matter and form. The second premise is a phainomenon; so, if that is accepted without further defense, only the first requires justification. The first premise is justified by the thought that since there is no generation ex nihilo, in every instance of change something persists while something else is gained or lost. In substantial generation or destruction, a substantial form is gained or lost; in mere accidental change, the form gained or lost is itself accidental. Since these two ways of changing exhaust the kinds of change there are, in every instance of change there are two factors present. These are matter and form.

How do we argue in favour of (making) a distinction? By making it and showing the benefits of doing so; these benefits are cashed out in terms of explanation: it has to be shown that the explanation of some phenomenon, *p*, is better, other things being equal, if it is given in two parts, i.e. with respect to *p*-under-the-aspect-*F* and to *p*-under-the-aspect-*G*. For this to work, there must be such things as '*p*-under-the-aspect-*F*', and the two must be different. That they are, i.e. that the distinction is not empty, is something *presupposed*, not *shown* by such an explanation.[6]

Even granting that this is an 'argument for' the distinction, the problem with it is that the crucial premiss – that there is no generation ex nihilo – requires an analysis of substantial change (the coming or ceasing to be of substances, i.e., in Aristotelian terminology, of generation and corruption) that seems to presuppose the matter/form distinction.

6. Perhaps an example helps. We are all familiar with the talk of 'motives' or of actions being 'motivated', done 'on purpose' or 'intentionally'. Suppose we want to explain what motives are, what it is for an action to be done 'for the sake of something'. At this point, many philosophers will want to distinguish between reasons and causes. Whether or not this is helpful then of course depends on whether there is such a distinction and whether both reasons and causes, at least potentially, fall within the remit of "motive".

Within the broader category of change, *De Gen. et Corr.* distinguishes alteration and other types of non-substantial change from generation in terms of what underlies:

> Since there is something which underlies, and the affection whose nature is to be predicated of this is something else, and since either of these can change, it is alteration when the underlying thing remains, being perceptible, but changes in its affections (whether they are opposites or intermediate) …But when the thing changes as a whole, without anything perceptible remaining as the same underlying thing (for example, when the seed as a whole becomes blood, or water air, or air water), a case of that sort is generation. (319b8–18)
> When the change of opposites is in quantity, we have increase or decrease; when it is in place, we have locomotion; when it is in an affection and a quality, we have alteration. But when nothing remains of which the other is an affection, or any kind of accident, then we have generation or destruction. (319b32–320a2)

A substance *x* comes into being not from nothing, but from another substance *y*. But to distinguish generation from non-substantial change, *x* has to be *new*, i.e. *x* and *y* have to be different, which is expressed as there being nothing *perceptible* remaining (first quote) or there being nothing *at all* remaining (second quote). The thing which does not remain (or at least is not seen to remain), but underlies, is matter.

According to Bostock (1995: 6), in 190a31–b10 "Aristotle is arguing that any case of coming to be is a case of coming to be *from* something, so that there is always something that forms the starting point of the change", and any case of coming to be is a case of becoming:

> …considering now the mere concept of becoming we may argue that if one thing is properly said to become another then obviously there must be something which does not persist throughout the change, for otherwise there would be no change; but equally there must be something which does persist throughout the change, for otherwise the change would merely consist in one thing coming to be where another had ceased to be, and there would be no reason to say that the one *became* the other. (1995: 6)

Again, what there is 'reason to say' depends very much on the example: it is perfectly appropriate, e.g., to say that when there was light, the world became illuminated, but it is much less clear that 'the world' is the kind of thing that underlies, that the coming-to-be of light was a change in something (air, presumably). That it is is a substantial claim about light, not something to be read off the grammar of the description.

2.3.2 There cannot be genesis ex nihilo: the puzzle of prime matter

2.3.3 What, on earth, are Aristotelian forms?

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Chapter 3

Physics II: Nature, teleological explanation, chance and necessity

3.1 Nature, natures, and the natural

After having shown that the analysis of change in terms of variation and constancy requires a distinction between matter and form, Aristotle starts the second book with a different question. Rather than asking what the world must be like in order to exhibit change, we now ask what is characteristic of changing things and introduce the fourfold distinction of 'causes' or principles. According to Charlton (1992: xvi-xvii), the leading question is: What is explanation in the natural sciences? Aristotle then takes us through the following steps:

II.1 its objects are natural things, distinguished from artefacts: things that have a nature = a source of their behaviour in themselves
II.2 natures can be form, but they can also be matter
II.3+7 fourfold classification of causes / types of explanatory factor
II.4-6 chance and luck can be fitted into this classification
II.8 validity of teleological explanation (= explanation by form)

3.1.1 Natural things and artefacts

A central conclusion of the whole of the *Physics* is that nature, *phusis*, itself is a final cause. "Nature" is used in two ways: as a subject of predication – "nature is an internal source of movement and rest" – and as a predicate, "…is natural" or "…has a nature": nature (in the first sense) is, according to some, the matter (and, according to others and Aristotle himself, the form) of things that have natures, i.e. things that are substances. The first sense is reducible to the second: to say that the nature of something is F is just to say that it is F by nature, i.e. naturally F.

Aristotle starts *Phys.* II.1 by stating what natures are. Some nature is a principle of change in the things in which it inheres (a) primarily (not in virtue of inhering in something else) and (b) per se, i.e. not per accidens (192b21–23). Both conditions distinguish natural things from product of craft: (a) artefacts, such as a bed or a coat, have inner principles of change, but only indirectly so, because their matter has them; (b) while healing of the doctor by herself also has an 'inner' principle, this is only accidentially so. The two distinctions cross-cut:

- The first distinction is between things to which natures belong: they may belong to two things, but only to one of them primarily (*protos* and then are principles of change only for the latter. The nature of the wooden bed is the principle of change only of the wood, though it also belongs to the bed. It belongs to the bed, however, only "per accidens" (Aquinas, Commentaria in octo libros Physicorum liber II lectio 3, §142, Leoninum edition).

- The second distinction, between having a property *kath'auto* (per se) and *kata sumbebēkos* (per aliud) rules out the doctor curing herself having a principle of change in herself and thus being a natural thing. Even though she produces a change in herself, she is not her own patient *kath'auto*, but only *kata sumbebēkos*, by concurrence'.[1]

Artifacts and natural beings are contrasted in terms of the efficient cause involved in their production: "None of them [that is, artifacts] has in itself the principle of its own production" (192a27–28). Can we then conclude that a thing is natural iff it has an inner principle of change? Yes, if we understand "principle" in a broader sense than "efficient cause": while natural things may rely and depend on things external to them for exercising their natural capacities (as e.g. nutrition, perception, locomotion), the change is still appropriately 'internal' to them (and not to its external efficient cause) if the 'good of' the change (its telos) is internal to them.[2]

This is so even in substantial changes, i.e. where an animal or a plant 'brings forth' / produces an animal or a plant of the same kind. In such cases, "the nature of an entity is the element common between it and what generated it" (Stavrianeas 2015: 58) and is transmitted – this last feature is what distinguishes natural generation from the generation of artefacts, where the form is typically changed (medicine, e.g., brings about health, not medicine): Even though its efficient cause is the form of the parent, the coming-to-be of the child still has a principle that is 'in it', because it shares its form with the parent.

We here find the new-age saying "become the person you (already) are" written large, and feel the strength of the Parmenidean dilemma: if you are already that person, then you cannot become it; but if you are not, then this is not the person you become. The solution, as in *Physics* I.8-9 is to distinguish what you are actually from what you are potentially – we get the even more fashionable "realise your potential".

3.1.2 Why natural science is not mathematics

In what way does the study of nature(s) involve the study of form(s)? Aristotle tackles this question in *Phys.* II.2 from a slightly oblique angle: in what way does the mathematician differ from the person who investigates nature? Aristotle generates a concern about this by highlighting two related but distinct points: First, the objects investigated by the mathematician, such as points, lines, planes, and solids are features of natural bodies; and second, it is apparently a goal of the natural scientist to grasp the nature of the sun and moon, and to determine whether the earth or the cosmos is spherical or not. But these would appear to be the concerns of the astronomer, who is a type of mathematician (193b22–30).

This initial set-up already puts some distance between Aristotle and the Platonists. This makes sense, as Aristotle not only wants to explain how natural science differs from mathematics in his sense, but also how it differs from the Platonist conception of mathematics, which subsumes (according to Aristotle, anyway) natural science. The Platonists misconstrue natural science by ascribing to it the method of mathematics:[3]

λανθάνουσι δὲ τοῦτο ποιοῦντες καὶ οἱ τὰς ἰδέας λέγοντες· τὰ γὰρ φυσικὰ χωρίζουσιν ἧττον ὄντα χωριστὰ τῶν μαθηματικῶν. (193b35-194a1)	The holders of the theory of Forms do the same, though they are not aware of it; for they separate the objects of natural science, which are less separable than those of mathematics. (Aristotle 2014: 733)	Those who talk about ideas do not notice that they too are doing this: they separate physical things though they are less separable than the objects of mathematics. (Aristotle 1992: 26)

Quite surprisingly, Aristotle seems to be claiming that the forms of natural objects are separable *to some degree*! At *Met.* H 1042a28-9, Aristotle says that Aristotelian forms are separable in account:

1. Somewhat confusingly, Aquinas (§145) also translates the second term of this second distinction as "per accidens", opposing it to things "coming to be through an intrinsic principle" (fiunt a principio intrinseco).

2. Because the *telos* is not necessarily realised (and may even always fail to be realised), this must be modified: the principle of change is internal (at best) insofar as its telos *would* be realised in the thing changing in the 'natural' course of events, even if the efficient cause of the change is external. Two further modifications are then still necessary, as Stavrianeas (2015: 57–58) points out: Because not all change is even potentially good for the changing thing, its principle is internal at most in the sense that the change is constrained by the changing thing's "formal nature". Also, the effect produced in the changing thing must stand in a per se, i.e. non-accidental relation to the change.

3. As will be discussed in sct. 3.1.3, they also misconstrue mathematics, by ascribing to it the method of metaphysics.

> …an account can be given of the form of thing which is separate from, does not involve, the account of its matter. Thus if some bronze constitutes a sphere, we can give an account of a sphere without mentioning bronze. It should be observed that though, in consequence of this, we might say that sphericality is separate from bronze, or from what it would be to be bronze, we are not entitled to say that a sphere is separate from bronze. Spheres are not something over and above lumps of material. (Charlton 1992: 94)

It seems quite clear, however, that separability *in this sense* is not at issue here.

Aristotle's own distinction between mathematics and natural science is made in terms of the *ways* in which mathematicians and natural philosophers respectively consider the objects of their study: mathematicians consider them as separable (whereas they are not), because they are separable-in-account, while the natural philosophers do not.

περὶ τούτων μὲν οὖν πραγματεύεται καὶ ὁ μαθηματικός, ἀλλ' οὐχ ᾗ φυσικοῦ σώματος πέρας ἕκαστον· οὐδὲ τὰ συμβεβηκότα θεωρεῖ ᾗ τοιούτοις οὖσι συμβέβηκεν· διὸ καὶ χωρίζει· χωριστὰ γὰρ τῇ νοήσει κινήσεώς ἐστι, καὶ οὐδὲν διαφέρει, οὐδὲ γίγνεται ψεῦδος χωριζόντων. (193b30-34)

Now the mathematician, though he too treats of these things, nevertheless does not treat of them as the limits of a natural body; nor does he consider the attributes indicated as the attributes of such bodies. That is why he separates them; for in thought they are separable from motion, and it makes no difference, nor does any falsity result, if they are separated. (Aristotle 2014: 733)

…but the mathematician does not consider them as boundaries of natural bodies. Nor does he consider things which supervene as supervening on such bodies. That is why he separates them; for they are separable in thought from change, and it makes no difference; no error results. (Aristotle 1992: 26)

The abstraction mathematicians make of the objects of their study is in turn interpreted by Aristotle as an abstraction from change; natural things, on the contrary, cannot be abstracted in this way. Aristotle puts this rather enigmatically: expressions for natural things are like "snubnosed" and not like "concave":

γίγνοιτο δ' ἂν τοῦτο δῆλον, εἴ τις ἑκατέρων πειρῷτο λέγειν τοὺς ὅρους, καὶ αὐτῶν καὶ τῶν συμβεβηκότων. τὸ μὲν γὰρ περιττὸν ἔσται καὶ τὸ ἄρτιον καὶ τὸ εὐθὺ καὶ τὸ καμπύλον, ἔτι δὲ ἀριθμὸς καὶ γραμμὴ καὶ σχῆμα, ἄνευ κινήσεως, σὰρξ δὲ καὶ ὀστοῦν καὶ ἄνθρωπος οὐκέτι, ἀλλὰ ταῦτα ὥσπερ ῥὶς σιμὴ ἀλλ' οὐχ ὡς τὸ καμπύλον λέγεται. [...] ἐπεὶ δ' ἡ φύσις διχῶς, τό τε εἶδος καὶ ἡ ὕλη, ὡς ἂν εἰ περὶ σιμότητος σκοποῖμεν τί ἐστιν, οὕτω θεωρητέον· ὥστ' οὔτ' ἄνευ ὕλης τὰ τοιαῦτα οὔτε κατὰ τὴν ὕλην. (193b37–194a5, 194a11–14)

This becomes plain if one tries to state in each of the two cases the definitions of the things and of their attributes. Odd and even, straight and curved, and likewise number, line, and figure, do not involve motion; not so flesh and bone and man – *these* are defined like snub nose, not like curved. […] Since two sorts of thing are called nature, the form and the matter, we must investigate its objects as we would the essence of snubness, that is neither independently of matter nor in terms of matter only. (Aristotle 2014: 733, 734)

That becomes clear if you try to define the objects and the things which supervene in each class. Odd and even, straight and curved, number, line, and shape, can be defined without change but flesh, bone, and man cannot. They are like snub nose, not like curved. […] Since there are two sorts of thing called nature, form and matter, we should proceed as if we were inquiring what snubness is: we should consider things neither without their matter nor in accordance with their matter. (Aristotle 1992: 26, 27)

"Subnosed", SIMOS, made its first appearance in the *Physics* at I.3, 186b23-24 where it was said to be a per se accident of / to supervene on NOSE, because NOSE enters into the definition of SNUB.

SIMOS is thus said of Socrates because of and in virtue of his having a concave nose; or rather: because of and in virtue of *his nose* having concavity, being concave. At *Met.* Z 1030b32-4, Aristotle says that "simos" is said of Socrates not because there is a definite feature, SNUB in it, but because there is something else (CONCAVE) in something else (Socrates' nose).

This feature of SNUB, according to Aristotle, brings out how the student of nature cannot abstract from the matter and concentrate only on the form (as the mathematicians do) nor abstract from the form and concentrate only on the matter (as the atomists do). For if we do the former, we only have NOSE and CONCAVE, and we cannot, using just them, describe Socrates as having a concave NOSE, rather than, e.g., having a nose and a concave mouth. If we do the latter, we will similarly not describe him adequately, for we will attribute him both having a nose and being concave, but not having a nose of a certain form.

This account 'involves' matter in at least two ways:

- By calling Socrates "snubnosed", we are talking about his matter: we are saying, of his body, that it has a material part, picked out by "nose", which has the property designated by "concave". On the level of forms, we have: SNUB is the same form ("the same in account") as CONCAVE NOSE; it is correctly analysed into these two simpler forms. But NOSE and CONCAVE are not forms of *Socrates*, nor of any part of his form, but of some part of his body which is his matter.
- By calling Socrates "snubnosed", we are saying that his nose *is* CONCAVE: we are not just co-predicating two forms, as we do when predicating ANTHROPOS MUSIKOS, but we are predicating something itself predicationally structures: *having a nose which is concave*. It is the *matter* of the nose that is CONCAVE, so in this sense "nose" occurs in our account as standing for the matter, not the form of Socrates' nose.

Both these two have consequences with respect to *separability*. Whereas PALE or CONCAVE are forms of Socrates and of his nose respectively because they have definite features, this is not the case for SNUB, nor is it for MAN: Socrates is a man iff and because something is in something else, i.e. because certain capacities are in flesh and bone or a particular sort of organic body.

I am not sure, however, that the requirement to specify the matter is specific in the way Lennox (2015: 20) seems to think it is:

> It is of the very essence of a living thing, and more generally of any natural object, to move, behave, act, and change in specific ways; in fact, in specifying what it is to be an eye or a leaf – or even air – one must mention capacities to function or change in specific ways. But it is also the case that those capacities are the capacities of specific materials, and thus any such definition must refer to a material structure constituted in precisely the way it must be in order to have the capacities to move and change as an eye or a leaf.

It is clear, however, that Aristotle criticises the "ancients" (specifically mentioning Empedocles and Democritus) for having been (uniquely, or at least mostly) 'concerned with matter' and underestimate the degree to which the student of nature must also know "the form or essence" (*to eidos* and *to ti estin*, 194b10). Against them, he argues that without asking questions about forms we cannot ask about the final causes and the outcome of natural processes.

3.1.3 Why natural science is not metaphysics

Even though natural science must concern *both* matter and form, it concerns matter en-formed (i.e.: insofar and to the extent that matter 'occurs in', 'is part of the account of' or 'is required by' natural forms), and form en-mattered, i.e. not forms 'as separable'. It is in this last characteristic that distinguishes it not just from mathematics, but from 'first philosophy' as well:

μέχρι δὴ πόσου τὸν φυσικὸν δεῖ εἰδέναι τὸ εἶδος καὶ τὸ τί ἐστιν; ἢ ὥσπερ ἰατρὸν νεῦρον ἢ χαλκέα χαλκόν, μέχρι τοῦ τίνος [γὰρ] ἕνεκα ἕκαστον, καὶ περὶ ταῦτα ἃ ἐστι χωριστὰ μὲν εἴδει, ἐν ὕλῃ δέ; ἄνθρωπος γὰρ ἄνθρωπον γεννᾷ καὶ ἥλιος. πῶς δ' ἔχει τὸ χωριστὸν καὶ τί ἐστι, φιλοσοφίας ἔργον διορίσαι τῆς πρώτης. (194a10-15)

How far then must the student of nature know the form or essence? Up to a point, perhaps, as the doctor must know sinew or the smith bronze (i.e. until he understands the purpose of each); and the student of nature is concerned only with things whose forms are separable indeed, but do not exist apart from matter. Man is begotten by man and by the sun as well. The mode of existence and essence of the separable it is the business of first philosophy to define. (Aristotle 2014: 735-6)

Up to what point, then, should the student of nature know the forms of things and what they are? Perhaps he should be like the doctor and the smith, whose knowledge of sinews and bronze etends only to what they are for; and he should confine himself to things which are separable in form, but which are in matter. What it is which is separable, and how things are with it, it is the work of first philosophy to define. (Aristotle 1992: 28)

It is not clear how the last remark about first philosophy being occupied with 'what is separable' is to be understood. Charlton seems to think that metaphysics studies 'forms as such':

> That which is separable (b14) is probably that which is separated in account, e.g. roundness, what it would be to be to be [sic] a man (if that is separable); and it is for first philosophy, for discussions like those in the *Metaphysics*, to determine how it is with such things, i.e. whether such expressions apply

> to entities in fact separate from quantities of matter, or have application only because it is possible to give separate accounts, distinguish separate possibilities, etc. (Charlton 1992: 98)

We have seen above that whether or not the matter of form/matter composites is itself an object of physical study, form certainly is. But how is physics concerned with (immutable) forms if it is to study the principles of change in things? According to Lennox (2015: 23), it is this quite formal characteristic of physical inquiry (stemming from Aristotle's definition of what a science is) which is responsible for Aristotelian physics asking teleological questions and giving teleological answers:

> …the natural philosopher's investigation of form is distinct from that of the metaphysician. Specifically the natural philosopher is to study the formal nature *in so far as it is that for the sake of which the materials that make up the material nature are present*. Thus, the natural scientist should study matter to the extent that it is for the sake of the form. (Lennox 2015: 23)

I do not think that we should take Aristotle's focus on teleological explanation to be built into the very demarcation of natural from first philosophy. Rather, its focus is on natural things, i.e. those exhibiting change, or on *kinesis* more generally, and on its four types of causes (that one of them, the final cause, is of particular importance, is a claim Aristotle argues for, not one he builds into the very conception of natural philosophy). In the *Metaphysics*, Aristotle makes a startling claim about what he (there, at least) calls "physics":

> if there is no other substance beyond the ones constituted by nature, physics will be the first science (E1 1026a27-29)

There are two notions of priority in play: between the "first" and all the other sciences and between the objects of such a first science and the objects of all the other sciences. Even though they closely match, the two ordering relations are not to be identified: metaphysics, after all, is the science of *all* being, albeit of being under a special aspect, *qua* being.

Commenting on the initial paragraph of Book I of the *Physics*, Aquinas explains Aristotle's demarcation of mathematics from metaphysics on the one and from natural science on the other hand thus:

Sciendum est igitur quod quaedam sunt quorum esse dependet a materia, nec sine materia definiri possunt: quaedam vero sunt quae licet esse non possint nisi in materia sensibili, in eorum tamen definitione materia sensibilis non cadit. Et haec differunt ad invicem sicut curvum et simum. Nam simum est in materia sensibili, et necesse est quod in eius definitione cadat materia sensibilis, est enim simum nasus curvus; et talia sunt omnia naturalia, ut homo, lapis: curvum vero, licet esse non possit nisi in materia sensibili, tamen in eius definitione materia sensibilis non cadit; et talia sunt omnia mathematica, ut numeri, magnitudines et figurae. Quaedam vero sunt quae non dependent a materia nec secundum esse nec secundum rationem; vel quia nunquam sunt in materia, ut Deus et aliae substantiae separatae; vel quia non universaliter sunt in materia, ut substantia, potentia et actus, et ipsum ens.
De huiusmodi igitur est metaphysica: de his vero quae dependent a materia sensibili secundum esse sed non secundum rationem, est mathematica: de his vero quae dependent a materia non solum secundum esse sed etiam secundum rationem, est naturalis, quae physica dicitur. (Commentaria in octo libros Physicorum liber I lectio I, §§3-4, Leoninum edition)

It must be understood, therefore, that there are some things whose existence depends upon matter, and which cannot be defined without matter. Further there are other things which, even though they cannot exist except in sensible matter, have no sensible matter in their definitions. And these differ from each other as the curved differs from the snub. For the snub exists in sensible matter, and it is necessary that sensible matter fall in its definition, for the snub is a curved nose. And the same is true of all natural things, such as man and stone. But sensible matter does not fall in the definition of the curved, even though the curved cannot exist except in sensible matter. And this is true of all the mathematicals, such as numbers, magnitudes and figures. Then, there are still other things which do not depend upon matter either according to their existence or according to their definitions. And this is either because they never exist in matter, such as God and the other separated substances, or because they do not universally exist in matter, such as substance, potency and act, and being itself.
Now metaphysics deals with things of this latter sort. Whereas mathematics deals with those things which depend upon sensible matter for their existence but not for their definitions. And natural science, which is called physics, deals with those things which depend upon matter not only for their existence, but also for their definition. (St. Thomas Aquinas 1999: ad loc.)

We have here two types of dependence on matter: something *x* may depend on something material *y* either "for its existence" (in the sense that *x* could not exist without *y*) or "for its definition" (in the sense that *x* could not

be the thing that it is without *y*, or perhaps without *y* being the thing that *it* is). Metaphysics deals with things independent in both ways, mathematics with things independent in the second but dependent in the first way and natural science with things that depend on material things in both ways.

3.2 The four causes

INTRO

3.2.1 "aition" is said in many ways

In II.3, we find an enumeration of different sorts of things which may be given as *aitia*:

Διωρισμένων δὲ τούτων ἐπισκεπτέον περὶ τῶν αἰτίων, ποῖά τε καὶ πόσα τὸν ἀριθμόν ἐστιν. ἐπεὶ γὰρ τοῦ εἰδέναι χάριν ἡ πραγματεία, εἰδέναι δὲ οὐ πρότερον οἰόμεθα ἕκαστον πρὶν ἂν λάβωμεν τὸ διὰ τί περὶ ἕκαστον (τοῦτο δ' ἐστὶ τὸ λαβεῖν τὴν πρώτην αἰτίαν) ... (194b16-20)

Now that we have established these distinctions, we must proceed to consider causes, their character and number. Knowledge is the object of our inquiry, and men do not think they know a thing till they have grasped the 'why' of it (which is to grasp its primary cause). (Aristotle 2014: 736)

These distinctions having been drawn, we must see if we can characterize and enumerate the various sorts of cause. For since the aim of our investigation is knowledge, and we think we have knowedge of a thing only when we can answer the question about it 'On account of what?' and that is to grasp the primary cause…(Aristotle 1992: 28)

The quest for knowledge is a search for an understanding of the *archai* and these are here further characterised as "causes" (*aitiai*) and the "why" (*to dia ti*) of things. These are said to be their "primary causes", the knowledge of which gives us knowledge of the things.

Again, Aristotle is not seeking to decide between them, but just lists the different ways in which something may be said to be an *aition* of something else:

ἕνα μὲν οὖν τρόπον αἴτιον λέγεται τὸ ἐξ οὗ γίγνεταί τι ἐνυπάρχοντος, οἷον ὁ χαλκὸς τοῦ ἀνδριάντος καὶ ὁ ἄργυρος τῆς φιάλης καὶ τὰ τούτων γένη·
ἄλλον δὲ τὸ εἶδος καὶ τὸ παράδειγμα, τοῦτο δ' ἐστὶν ὁ λόγος ὁ τοῦ τί ἦν εἶναι καὶ τὰ τούτου γένη (οἷον τοῦ διὰ πασῶν τὰ δύο πρὸς ἕν, καὶ ὅλως ὁ ἀριθμός) καὶ τὰ μέρη τὰ ἐν τῷ λόγῳ.
ἔτι ὅθεν ἡ ἀρχὴ τῆς μεταβολῆς ἡ πρώτη ἢ τῆς ἠρεμήσεως, οἷον ὁ βουλεύσας αἴτιος, καὶ ὁ πα τὴρ τοῦ τέκνου, καὶ ὅλως τὸ ποιοῦν τοῦ ποιουμένου καὶ τὸ μεταβάλλον τοῦ μεταβαλλομένου.
ἔτι ὡς τὸ τέλος· τοῦτο δ' ἐστὶν τὸ οὗ ἕνεκα, οἷον τοῦ περιπατεῖν ἡ ὑγίεια· διὰ τί γὰρ περιπατεῖ; φαμέν "ἵνα ὑγιαίνῃ", καὶ εἰπόντες οὕτως οἰόμεθα ἀποδεδωκέναι τὸ αἴτιον. καὶ ὅσα δὴ κινήσαντος ἄλλου μεταξὺ γίγνεται τοῦ τέλους, οἷον τῆς ὑγιείας ἡ ἰσχνασία ἢ ἡ κάθαρσις ἢ τὰ φάρμακα ἢ τὰ ὄργανα· πάντα γὰρ ταῦτα τοῦ τέλους ἕνεκά ἐστιν, διαφέρει δὲ ἀλλήλων ὡς ὄντα τὰ μὲν ἔργα τὰ δ' ὄργανα. (194b23–195a2)

In one way, then, that out of which a thing comes to be and which persists, is called a cause, e.g. the bronze of the statue, the silver of the bowl, and the genera of which the bronze and the silver are species.
In another way, the form or the archetype, i.e. the definition of the essence, and its genera, are called causes (e.g. of the octave the relation of 2:1, and generally number), and the parts in the definition.
Again, the primary source of the change or rest; e.g. the man who deliberated is a cause, the father is cause of the child, and generally what makes of what is made and what changes of what is changed.
Again, in the sense of end or that for the sake of which a thing is done, e.g. health is the cause of walking about. ('Why is he walking about?' We say: 'To be healthy', and, having said that, we think we have assigned the cause.) The same is true also of all the intermediate steps which are brought about through the action of something else as means towards the end, e.g. reduction of flesh, purging, drugs, or surgical instruments are means towards health. All these things are for the sake of the end, though they differ from one another in that some are activities, others instruments.(Aristotle 2014: 736-737)

According to one way of speaking, that out of which as a constituent a thing comes to be is called a cause; for example, the bronze and and the silver and their genera would be the causes respecively of a statue and a loving-cup.
According to another, the form or model is the cause; this is the account of what the being would be, and its genera – thus the cause of an octave is the ratio two to one, and more generally number – and the parts which come into the account.
Again, there is the primary source of the change or the staying unchanged: for example, the man who has deliberated is a cause, the father is a cause of the child, and in general that which makes something of that which is made, and that which changes something of that which is changed.
And again, a thing may be a cause as the end. That is what something is for, as health might be what a walk is for. On account of what does he walk? We answer 'To keep fit' and think that, in saying that, we have given the cause. And anything which, the change being effected by something else, comes to be on the way to the end, as slimness, purging, drugs, and surgical instruments come to be as means to health: all these are for the end, but differ in that the former are works and the latter tools. (Aristotle 1992: 28-29)

In this very first introduction of "*aition* is said in many ways", Aristotle characterises the different ways in terms of participle constructions:

that out of which as a constituent (*to ex ou gignetai ti enuparchontos*), asked of something that comes to be;
that what it really is (*to ti ēn einai*), asked of something that has an account of what it's being would be;
the where it comes from (*archē*), asked of something that is changed (or stays unchanged) or is made;
the what something is for (*to hou heneka*), asked of something that is for an end, as a tool or as an activity.

In particular with respect to the final cause, Aristotle presents these constructions as means of picking out that of which we speak if we understand the question "on account of what?" (*dia ti*?) in one of the respective senses.

He then illustrates how several of these participative constructions apply to a statue: that out of which is the bronze, that where it comes from is the art of statue-making. They both are causes of the statue *as a statue*, but not in the same way: The bronze is a cause of the statue *as* matter, the art of statue-making is a cause of it *as* that from which the change proceeds. Labour is where strength comes from (its efficient cause), while strength is what labour is done for (its final cause).

MORE

Aristotle then proceeds to make the even more startling claim that not just can be different things causes in different ways in which "cause" is said, but that one and the same thing can be one type of cause in different ways: "the same thing is the cause of opposites". The presence of the steersman is the efficient cause of the ship's being saved; the absence of the steersman is the efficient cause of the ship's being lost, in the sense that the loss of the ship is "set down to it".

Especially in this last use, it is clear that Aristotle is using the ways in which "cause" is said to distinguish between different types of explanation.

3.2.2 The four causes as explanations

In *Met.* Δ, we have the following list:

material "constituent out of which" (1013a24)
formal "form and pattern" (1013a26)
motive / efficient "first origin of alteration or rest" (1013a29)
final "a thing's fulfilment" (1013a32)

To the question, "why is this a statue?", Aristotle can give four sorts of answers: This is a statue because it is made of marble; because it is in the shape of David; because Michelangelo sculpted it; because Michelangelo wanted to depict the figure of David in marble (because he needed the money, perhaps).

Shields 2015 illustrates and summarises this as follows:

> Aristotle's attitude towards explanation is best understood first by considering a simple example he proposes in *Physics* ii 3. A bronze statue admits of various different dimensions of explanation. If we were to confront a statue without first recognizing what it was, we would, thinks Aristotle, spontaneously ask a series of questions about it. We would wish to know what it is, what it is made of, what brought it about, andwhat it is for. In Aristotle's terms, in asking these questions we are seeking knowledge of the statue's four causes (aitia): the formal, material, efficient, and final. According to Aristotle, when we have identified these four causes, we have satisfied a reasonable demand for explanatory adequacy.
> More fully, the four-causal account of explanatory adequacy requires an investigator to cite these four causes:
>
> **material** that from which something is generated and out of which it is made, e.g. the bronze of a statue.

formal the structure which the matter realizes and in terms of which it comes to be something determinate, e.g., the shape of the president, in virtue of which this quantity of bronze is said to be a statue of a president.

efficient the agent responsible for a quantity of matter's coming to be informed, e.g. the sculptor who shaped the quantity of bronze into its current shape, the shape of the president.

final the purpose or goal of the compound of form and matter, e.g. the statue was created for the purpose of honoring the president.

In *Physics* ii 3, Aristotle makes twin claims about this four-causal schema: (i) that citing all four causes is necessary for adequacy in explanation; and (ii) that these four causes are sufficient for adequacy in explanation.

3.2.3 The four causes as 'becauses'

In *De Anima*, however, things seem a little more complicated:

> The soul is the cause and source of the living body. But cause and source are meant in many ways [or are homonymous]. Similarly, the soul is a cause in accordance with the ways delineated, which are three: it is (i) the cause as the source of motion [= the efficient cause], (ii) that for the sake of which [= the final cause], and (iii) as the substance of ensouled bodies. That it is a cause as substance is clear, for substance is the cause of being for all things, and for living things, being is life, and the soul is also the cause and source of life. (DA 415b8–14)

3.3 Chance and necessity

INTRO

3.3.1 Aristotelian chance

II.4 asks whether there is chance, II.5 what it is and II.6 then distinguishes two type of chance: luck, and *to automaton*.

He starts in II.4 by pointing out that even if, as many believe, everything has a cause, there might still be chance. But even if there is chance, it is not responsible (II.5) for things which come to be, in the same way, always or at least for the most part. This is, at first, an almost linguistic observation: if we know of something that happens a certain way, that similar things always happen this way or that it is natural for them to happen this way, we have the justification we need to question someone else's claim that it happened by chance. Observations of exceptionless and 'natural' (ceteris paribus) regularities are inimical to diagnoses of chance because, rightly or wrongly, we take the former as evidence for the presence of an underlying cause.

Physics II.4 introduces "luck" and "the automatic" as causes, both for the being and the coming to be of things. Calling luck the cause of the unexpected encounter at the market (or calling the encounter an "automatic outcome") is opposed to saying that it has a "definite cause", and to saying that is has a cause among the list recognised e.g. by Empedocles. II.5 then narrows down the things that may be said to be caused by luck or the automatic, excluding first things that are "of necessity and always", then "that which is for the most part", and finally restricting its application to things which "come to be for something", said to include things that "might be done as an outcome of thought or nature".

The things that come to be 'for something' are the outcome either of nature or of thought. Things that come to be by chance belong to the latter group, and, within it, are those that come about by virtue of concurrence, i.e. are the things which, though they might have been done for something, in fact were not. So we get as the Aristotelian definition of chance: a cause by virtue of concurrence of things which come to be neither always nor for the most parts and are such as to be for something.

II.5 then says that things that are comes to be by virtue of concurrence, i.e. things that have causes which are its causes by concurrence, may be said to come about by luck (to be outcomes of luck or automatic outcomes), even if

they also have determinate causes. With actions, such determinate causes are the intentions to bring them about, and actions which realise another, concurrent intention than the one that motivated them are outcomes of luck. The example of going to the market is instructive: when Socrates both intends to go to the market and also intends or wishes to meet his friend Theatetus (though does not intend to meet him by going to the market), it may happen that by realising his first intention, he also realises his second intention: going to the market, he meets Theatetus by chance, as we say. We may assume that the going to the market and the meeting of Theatetus are one and the same event, or even action; though both intentions are realised by it, the action was *motivated* (i.e.: caused) only by the first one; it was not done *for* the second intention of meeting the friend.

II.6 extends the category of what comes about by luck (ie. by concurrence) to the wider category of automatic outcomes. Luck is a characteristic of intended outcomes of actions that were not motivated by what they brought about, and thus restricted to activites of things capable of choosing, excluding inanimate objets, animals and children. Automatic outcomes are things that happen for someone's good, because of an activity of them, but include unintended consequences.

II.7 brings us back to the four causes, not introduces as "the many things the quesiton 'On account of what?' embraces: the 'what is it?' (formal cause), 'what in the first instance effects the change?' (efficient cause), 'what is the thing for?' (final cause) and 'what is the thing of?' (material cause). Aristotle notes that often we have coincidence, not just of the formal with the final cause (where what a thing is is what it is for), but also of the formal/final cause with the form of the efficient cause, as when"a man gives birth to a man".

In II.7, Aristotle argues that we need not just three causes, but all four (i.e. that a full explanation of natural phenomena must appeal to all four causes), because the final cause is implicitly presupposed in the questions what something is and what causes its motion (cf. Kelsey 2015: 40). II.8 argues that nature (in the sense of form), because it is a principle (arche), is a final cause:

> …Aristotle's use of the definition [of nature as the principle of *kinesis*] here complements the use he makes of it in II.7. There the moral was that nature (as form) can be a motive principle *if* it is an end; here [in II.8] the moral is that nature will be such a principle *only if* it is an end. (Kelsey 2015: 43)

Physics II.8 presents Aristotle's case for the centrality of final causation for the study of nature. The main argument is that it is only by appeal to final causes that we can explain regularities, both those that hold by necessity (i.e.: without exception, always) and those that hold for the most part. The reason given is that the only alternative explanation (that things are the outcome of luck or coincidence) is acceptable only for things we recognise as exceptions.

Natural things – i.e. things that have an inner principle of change – are and come to be due to nature; their inner principle of change is thus their 'for something', the final cause of their being and coming to be, and this is also their form, i.e. their nature-understood-as-form. It is the final = formal cause, its nature-as-form that explains the progression in the changes a natural thing naturally undergoes:

φύσει γάρ, ὅσα ἀπό τινος ἐν αὐτοῖς ἀρχῆς συνεχῶς κινούμενα ἀφικνεῖται εἴς τι τέλος· ἀφ' ἑκάστης δὲ οὐ τὸ αὐτὸ ἑκάστοις οὐδὲ τὸ τυχόν, ἀεὶ μέντοι ἐπὶ τὸ αὐτό, ἂν μή τι ἐμποδίσῃ. τὸ δὲ οὗ ἕνεκα, καὶ ὃ τούτου ἕνεκα, γένοιτο ἂν καὶ ἀπὸ τύχης ...ἀλλ' ὅταν τοῦτο αἰεὶ ἢ ὡς ἐπὶ τὸ πολὺ γένηται, οὐ συμβεβηκὸς οὐδ' ἀπὸ τύχης· ἐν δὲ τοῖς φυσι κοῖς ἀεὶ οὕτως, ἂν μή τι ἐμποδίσῃ. (199b15-20, 24-26)

For those things are natural which, by a continuous movement originated from an internal principle, arrive at some end: the same end is not reached from every principle; nor any chance end, but always the tendency in each is towards the same end, if there is no impediment. The end and the means towards it may come about by chance. […] But when an event takes place always or for the most part, it is not accidental or by chance. In natural products the sequence is invariable, if there is no impediment. (Aristotle 2014: 753)

A thing is due to nature, if it arrives, by a continuous process of change, starting from some principle in itself, at some end. Each principle gives rise, not to the same thing in all cases, nor to any chance thing, but always to something proceeding towards the same thing, if there is no impediment. What something is for, and what is for that, can also come to be as the outcome of luck …[…], but when a thing comes to be always or for the most part, it is not a concurrent happening, nor the outcome of luck. Now with that which is natural it is always thus if there is no impediment. (Aristotle 1992: 41–42)

3.3.2 Autonomous causation

When Aristotle characterises natural things as those that have an inner principle of change, does he not contradict what he will later say in *Phys.* VIII that nothing changes itself? It depends on what we mean by "change". If the change that something *x* undergoes is by its form, then *this* is what changes it; if the 'change' is by its matter, it is not really change.

The latter claim – of 'autonomous causation' – concerns those cases of a passage from potentiality to actuality that do not, according to Aristotle, constitute a change. In *De An.* II 417b1-16, Aristotle makes the claim that a man who passes from (i) having knowledge (of what a dog is) but not exercising it to (ii) exercising this knowledge (encountering a dog, she knows that this is a dog) does not *thereby* undergo change. The lack of opportunity for the exercise of the knowledge, i.e. the fact that the perceptual situation of the knower does not present her with a dog, is an impediment, and the impediment is an impediment for the *manifestation* of the change, not for the change itself.

That natural things have an *inner* principle of change means that nothing additional, nothing external is needed for them to change: their change is initiated by themselves and this initiation can only be impeded by something external. Such 'changes' (or rather: passages from potentiality to actuality) that happen by themselves are attributed by Aristotle to nature-as-matter. It is in this context that he uses "a word for nature which seems to mean active striving: *hormē*, *An. po.* II 95a1, *Phys.* II 192b18-29, Met. Δ 1023a9,18,23, and, most importantly because it is a careful passage, *E.E.* II 1224a18-b9." (Charlton 1992: 92).

3.3.3 The priority of teleological explanation

II.7. often, the three non-material causes coincide: the form / what a thing is = (the form of) the thing which effects the change = what the thing is for. E.g. a human *x* produces a human; cause is: human. Human is the form of *x*; *x* effects the change (in the underlying matter); human is what the change (the becoming human) is for. (the standard interpretation seems very different: that the efficient cause is a form operating a tergo, and the final cause a form operating a fronte) – cf Mure (1932: ch1)) cf De An II 415b8-27

8. the 'for something' is present in things which are and come to be due to nature

9. if there is absolute necessity (as opposed to 'necessity only on some hypothesis'), it is teleological (on the distinction of necessities, cf Met Δ 5)

Chapter 4

Physics III: Motion and the Infinite

4.1 Aristotelian change

That there is change, according to Aristotle, is something we may just assume. To think we have to argue for the existence of change is "to seek an explanation whenwe are in the position of not needing one" and shows a lack of metaphysical taste (254a30-31, 1999: 9). Nevertheless, Aristotle argues for this fundamental and self-obvious presupposition: to assume otherwise, to assert that there is no motion, is to be in a pragmatically instable state, because, for metaphysical reasons, no one could ever become *convinced* of immutabilism. This argument is made by Aristotle in *Physics VIII.3*:

ὅτι μὲν τοίνυν οὐχ οἷόν τε πάντ' ἠρεμεῖν, εἴρηται μὲν καὶ πρότερον, εἴπωμεν δὲ καὶ νῦν. εἰ γὰρ καὶ κατ' ἀλήθειαν οὕτως ἔχει καθάπερ φασί τινες, εἶναι τὸ ὂν ἄπειρον καὶ ἀκίνητον, ἀλλ' οὔτι φαίνεταί γε κατὰ τὴν αἴσθησιν, ἀλλὰ κινεῖσθαι πολλὰ τῶν ὄντων. εἴπερ οὖν ἔστιν δόξα ψευδὴς ἢ ὅλως δόξα, καὶ κίνησις ἔστιν, κἂν εἰ φαντασία, κἂν εἰ ὁτὲ μὲν οὕτως δοκεῖ ὁτὲ δ' ἑτέρως· ἡ γὰρ φαντασία καὶ ἡ δόξα κινήσεις τινὲς εἶναι δοκοῦσιν. (254a16-29)

Now we have said before that it is impossible that all things should be at rest: nevertheless we may now repeat the point. For even if it is really the case, as some assert, that what is is infinite and motionless, it certainly does not appear to be so if we follow sense-perception: many things that exist appear to be in motion. Now if there is such a thing as false opinion or opinion at all, there is also motion; and similarly if there is such a thing as imagination, or if it is the case that anything seems to be different at different times; for imagination and opinion are thought to be motions of a kind. (Aristotle 2014: 932)

We have in fact already argued that itis not possible for all things to be at rest, but we shall argue the point again now. For if things are truly like this, as some claim, and what-is is infinite and motionless, at least this is not at all how it appears to the senses, but many being *seem* to move. If, then, there is false opinion, or opinion in general, there is also motion, and even if there is only imagination, or even if opinion varies, still there is motion. For imagination and opinion are considered to be kinds of motion. (Aristotle 1999: 8)

4.1.1 What change is

Physics III.1 starts with an investigation of change, culmination in a definition (201a9-19); III.2 then characterises change further, as transmission of a form (202a3-12) and III.3 locates change in that which is changed.

III.1 says that everything is either only actually or actually and potentially of one of the categories of being ("that-which-is"):

ἔστι δὴ [τι] τὸ μὲν ἐντελεχείᾳ μόνον, τὸ δὲ δυνάμει καὶ ἐντελεχείᾳ, τὸ μὲν τόδε τι, τὸ δὲ τοσόνδε, τὸ δὲ τοιόνδε, καὶ τῶν ἄλλων τῶν τοῦ ὄντος κατηγοριῶν ὁμοίως. [...] οὐκ ἔστι δὲ κίνησις παρὰ τὰ πράγματα· μεταβάλλει γὰρ ἀεὶ τὸ μεταβάλλον ἢ κατ' οὐσίαν ἢ κατὰ ποσὸν ἢ κατὰ ποιὸν ἢ κατὰ τόπον, κοινὸν δ' ἐπὶ τούτων οὐδὲν ἔστι λαβεῖν, ὡς φαμέν, ὃ οὔτε τόδε οὔτε ποι (201a.) σὸν οὔτε ποιὸν οὔτε τῶν ἄλλων κατηγορημάτων οὐθέν· (200b26-28, 200b31-201a1)

Some things are in fulfilment only, others in potentiality and in fulfilment—one being a this', another so much, another such and such, and similarly for the other categories of being. […] There is no such thing as motion over and above the things. It is always with respect to substance or to quantity or to quality or to place that what changes changes. But

it is impossible, as we assert, to find anything common to these which [201a1] is neither 'this' nor quantity nor quality nor any of the other predicates. (Aristotle 2014: 757)

Things are – some only actually, some potentially and actually – either (a) a 'this'; or (b) so much; or (c) of such a kind, and likewise they are in the other categories of that-which-is. […] There is no change apart from actual things; for whatever alters always does so in respect either of substance, or of quantity, or of qualification, or of place, and there is, as we assert, nothing to be found as a common item superior to these, which is neither a 'this' nor a quantity nor a qualification nor any of the other occupants of the categories …(Aristotle 1993: 1)

This is an expression of both Aristotelian realism and of his ontological pluralism: there is no such abstract thing as 'the' change or 'the' motion – what changes or moves are always actual things that underlie the movement or change. Everything there is belongs to one of the ten categories, and this is also why there is no such thing as "everything", "the universe", "being": there is no highest genus of being, nothing which transcends the categories and does not belong to any single one of them.

Of things said without combination, each signifies either: (i) a substance (ousia); (ii) a quantity; (iii) a quality; (iv) a relative; (v) where; (vi) when; (vii) being in a position; (viii) having; (ix) acting upon; or (x) a being affected. (Cat. 1b25–27)

DISCUSS EARLIER DISCUSSION THAT, IF THERE WERE A HIGHEST GENUS, THERE WOULD BE JUST ONE DIMENSION OF VARIATION

With things in every category, there is a dimension of contrast characterised by 'opposites':

ἕκαστον δὲ διχῶς ὑπάρχει πᾶσιν, οἷον τὸ τόδε (τὸ μὲν γὰρ μορφὴ αὐτοῦ, τὸ δὲ στέρησις), καὶ κατὰ τὸ ποιόν (τὸ μὲν γὰρ λευκὸν τὸ δὲ μέλαν), καὶ κατὰ τὸ ποσὸν τὸ μὲν τέλειον τὸ δ' ἀτελές. ὁμοίως δὲ καὶ κατὰ τὴν φορὰν τὸ μὲν ἄνω τὸ δὲ κάτω, ἢ τὸ μὲν κοῦφον τὸ δὲ βαρύ. ὥστε κινήσεως καὶ μεταβολῆς ἔστιν εἴδη τοσαῦτα ὅσα τοῦ ὄντος. (201a1-9)

Now each of these belongs to all its subjects in either of two ways: namely, substance – the one is its form, the other privation; in quality, white and black; in quantity, complete and incomplete. Similarly, in respect of locomotion, upwards and downwards or light and heavy. Hence there are as many types of motion or change as there are of being. (Aristotle 2014: 757–758)

But each [occupant of a category] is present in everything in two ways, e.g. the 'this' (one case of it is the form, the other is the privation); and in respect of qualification (one case is *white* and the other *black*); and in respect of quantity (one case is *complete* and the other *incomplete*). So too in respect of locomotion, one case is *above*, the other is *below*, or one case is *light*, the other is *heavy*. So that there are just as many species of change and alteration as of that-which-is. (Aristotle 1993: 2)

MORE ABOUT DEGREES OF FREEDOM AND DIMENSIONS OF INDEPENDENT VARIATION

Having noted that for each of the things in any of the categories, we can say that it is a certain way, Aristotle notes that it can change the way it is, giving his famous definition of change in terms of the actuality/potentiality distinction, as relativised to one of the categories:

διῃρημένου δὲ καθ' ἕκαστον γένος τοῦ μὲν ἐντελεχείᾳ τοῦ δὲ δυνάμει, ἡ τοῦ δυνάμει ὄντος ἐντελέχεια, ᾗ τοιοῦτον, κίνησίς ἐστιν, οἷον τοῦ μὲν ἀλλοιωτοῦ, ᾗ ἀλλοιωτόν, ἀλλοίωσις, τοῦ δὲ αὐξητοῦ καὶ τοῦ ἀντικειμένου φθιτοῦ (οὐδὲν γὰρ ὄνομα κοινὸν ἐπ' ἀμφοῖν) αὔξησις καὶ φθίσις, τοῦ δὲ γενητοῦ καὶ φθαρτοῦ γένεσις καὶ φθορά, τοῦ δὲ φορητοῦ φορά. (201a9-15)

We have distinguished in respect of each class between what is in fulfilment and what is potentially; thus the fulfilment of what is potentially, as such, is motion – e.g. the fulfilment of what is alterable, as alterable, is alteration; of what is increasable and its opposite, decreasable (there is no common name for both), increase and decrease; of what can come to be and pass away, coming to be and passing away; of what can be carried along, locomotion. (Aristotle 2014: 758)

There being a distinction, in respect of each kind [of being], between [being] actually and [being] potentially, the actuality of that which potentially is, *qua* such, is change. For example: the actuality of what admits of qualitative change, *qua* admitting of qualitative change, is qualitative change; of what admits of increase and decrease (there is no common term to cover both), it is increase and decrease; of what admits of coming-to-be and ceasing-to-be, it is coming-to-be and ceasing-to-be; of what admits of locomotion, it is locomotion. (Aristotle 1993: 2)

For each of the categories, we get a type of change: (THIS IS HIGHLY SPECULATIVE)

substances have the potentiality to come to be and there is change when they have come to be (substantial change);

quantities have the potentiality to increase and there is change when have increased (increase);
qualities have the potentiality to alter and there is change when they have altered (alteration);
relatives have the potentiality to be gained and lost and there is change when they have been gained or lost (Cambridge change);
places have the potentiality to be occupied and there is change when they become occupied (motion);
times have the potentiality to be present and there is change when they become present (time);

REMARKS ON THE ACTUALITY/POTENTIALITY DISTINCTION BEING BROADER THAN the matter/form distinction

'Being is said in many ways': according to the categories, with respect to degree: opposites (which are not properties), and with respect to mode: actual / potential, to be potentially *F* is a way of being *F*.

Why is change the actuality of a potentiality *as* potentiality and why is it not the actuality of a potentiality *as* actuality?

THIS IS IN "ARISTOTLE-RELATIONS.TEX"

4.1.2 Active and passive change

In III.2, Aristotle argues that the account of change as the actualisation of a potentiality as potentiality solves the problems of his predecessors. To 'locate' change in (i.e.: to identify it with) the opposites (hot and cold, e.g.) between which the change (of getting warmer, e.g.) occurs would require locating it (identifying it) more specifically with the privation: the getting warmer cannot be the being hot, so it must be the privation of cold.

Already in III.1, Aristotle said that natural things that produce change are themselves changed because they have an inner principle of change. When they produce change, a potentiality is actualised and in this respect and because this potentiality is 'in' them, they change. This becomes clearer at 202a3-5: things that produce change are themselves changed if (and also because) they are potentially changeable, i.e. have an *inner* principle of change.

4.1.3 The location of change

III.3 addresses the question of the location of change. "Location" is not to be understood just spatially; because change is, one the one hand, nothing over and above what undergoes it – because "change is in the changeable" –, but also, on the other hand, between opposites, i.e. between some *F* and some *G* such that nothing in actuality can be both *F* and *G*, we have to distinguish between what changes and what is changed and we have to ask which of the two the changeable (i.e.: the change) is.

Aristotle first gives his 'one in number, but two in account' account of the manifestation of reciprocal powers. The change, the warming of the air, occurs when the potentiality of the fire to warm is activated, as potentiality, and when the potentiality of the air to be warmed is activated, as potentiality. The two potentialities, as potentialities, are different, for it is one thing to warm and another thing to be warmed (for not everything that warms is also thereby warmed). As actualities and "in operation", however, they are one and the same:

Καὶ τὸ ἀπορούμενον δὲ φανερόν, ὅτι ἐστὶν ἡ κίνησις ἐν τῷ κινητῷ· ἐντελέχεια γάρ ἐστι τούτου [καὶ] ὑπὸ τοῦ κινητικοῦ. καὶ ἡ τοῦ κινητικοῦ δὲ ἐνέργεια οὐκ ἄλλη ἐστίν· δεῖ μὲν γὰρ εἶναι ἐντελέχειαν ἀμφοῖν· κινητικὸν μὲν γάρ ἐστιν τῷ δύνασθαι, κινοῦν δὲ τῷ ἐνεργεῖν, ἀλλ' ἔστιν ἐνεργητικὸν τοῦ κινητοῦ, ὥστε ὁμοίως μία ἡ ἀμφοῖν ἐνέργεια ὥσπερ τὸ αὐτὸ διάστημα ἓν πρὸς δύο καὶ δύο πρὸς ἕν, καὶ τὸ ἄναντες καὶ τὸ κάταντες· ταῦτα γὰρ ἓν μέν ἐστιν, ὁ μέντοι λόγος οὐχ εἷς· ὁμοίως δὲ καὶ ἐπὶ τοῦ κινοῦντος καὶ κινουμένου. (202a13-21)

The solution of the difficulty is plain: motion is in the movable. It is the fulfilment of this potentiality by the action of that which has the power of causing motion; and the actuality of that which has the power of causing motion is not other than the actuality of the movable; for it must be the fulfilment of both. A thing is capable of causing motion because it can do this, it is a mover because it actually does it. But it is on the movable that it is capable of acting. Hence there is a single actuality of both alike, just as one to two and two to one are the same interval, and the steep ascent and the steep descent are one—for these are one and the same, although their definitions are not one. So it is with the mover and the moved. (Aristotle 2014: 761)

Again – a point which makes difficulty – it is manifest that the change is in that which is changeable. For it is the actuality of this, brought about by that which is productive of change. Yet the operation of that which is productive of change, also, is not other – there must in fact be an actuality of both – for it is productive of change by its being capable of so doing, and it produces change by its operation, but it is such as to operate on what is changeable; so that the operation of both is one in the same way as it is the same interval from 1 to 2 as from 2 to 1, and as the uphill and the down-hill – these are one, yet their definition is not one, and similarly with that which produces and undergoes change. (Aristotle 1993: 4)

There is just one process of warming and it realises both the potentiality of *a* to warm *b* and *b*'s potentiality of being warmed by *a*. But where is it, where does it take place and what things are undergoing it? Aristotle discusses what he calls a "formal difficulty" (*aporia logikē*) with respect to the warming ("*A*") of *b* by *a* and the being warmed ("*B*") of *b* by *a*.

We assume, first, that *A* and *B* have different operations in that *A* is active and *B* passive: *A* is the action of *a* and *B* is the being acted upon of *b*. Even under that assumption, however (and also independently of it), *A* and *B* are both changes and have equally good claims to be 'the' change in the situation. But then we have no good answer to the question where *A* is:

- If *A* is 'in' *a* then, because *A* is a change, either *a* changes or it is the case that *a* 'has' change (in itself) but does not change.
- If *A* and *B* are 'in' *b*, then *b* undergoes one change in virtue of 'having' two changes.

Both horns of the dilemma lead to absurdity and we have to deny the assumption that created the dilemma: *A* and *B* do not have different operations.

We thus conclude that *A* and *B* have the same operation – they are in one sense one, even though they differ in form. Aristotle notes two difficulties with this view:

1. Will it not then follow that everything that warms is also warmed? *A*, after all, is the warming and *B* is the being warmed and if they are one and are *a*'s (in the sense that *A* is *a*'s), will it not then follow that *a* both warms and is warmed?
2. If *B* is in *b* and *A* and *B* are one, will it not follow that *A* is in *b* as well? If *A* is in *b*, however, what prevents us from saying that *b* warms (and not just: is warmed)?

Aristotle gives a negative answer to the first and a positive answer to the second question, explaining why in both cases the absurd consequences do not follow.

With respect to the second problem, Aristotle points out that *A* is in *b* in the sense in which *b* is *A*'s object (and not in the sense in which *b* would be *A*'s subject): *A* is *on b* and in this sense in *b*.

With respect to the first problem, Aristotle introduces another, *sui generis* type of identity, in addition to identity-in-form and identity-in-reality:[1]

ἢ οὔτε τὸ τὴν ἄλλου ἐνέργειαν ἐν ἑτέρῳ εἶναι ἄτοπον (ἔστι γὰρ ἡ δίδαξις ἐνέργεια τοῦ διδασκαλικοῦ, ἔν τινι μέντοι, καὶ οὐκ ἀποτετμημένη, ἀλλὰ τοῦδε ἐν τῷδε), οὔτε μίαν δυοῖν κωλύει οὐθὲν τὴν αὐτὴν εἶναι (μὴ ὡς τῷ εἶναι τὸ αὐτό, ἀλλ' ὡς ὑπάρχει τὸ δυνάμει ὂν πρὸς τὸ ἐνεργοῦν), οὔτ' ἀνάγκη τὸν διδά σκοντα μανθάνειν, οὐδ' εἰ τὸ ποιεῖν καὶ πάσχειν τὸ αὐτό ἐστιν, μὴ μέντοι ὥστε τὸν λόγον εἶναι ἕνα τὸν <τὸ> τί ἦν εἶναι λέγοντα, οἷον ὡς λώπιον καὶ ἱμάτιον, ἀλλ' ὡς ἡ ὁδὸς ἡ Θήβηθεν Ἀθήναζε καὶ ἡ Ἀθήνηθεν εἰς Θήβας, ὥσπερ εἴρηται καὶ πρότερον; οὐ γὰρ ταὐτὰ πάντα ὑπάρχει τοῖς ὁπωσοῦν τοῖς αὐτοῖς, ἀλλὰ μόνον οἷς τὸ εἶναι τὸ αὐτό.
[...] ὅλως δ' εἰπεῖν οὐδ' ἡ δίδαξις τῇ μαθήσει οὐδ' ἡ ποίησις τῇ παθήσει τὸ αὐτὸ κυρίως, ἀλλ' ᾧ ὑπάρχει ταῦτα, ἡ κίνησις· τὸ γὰρ τοῦδε ἐν τῷδε καὶ τὸ τοῦδε ὑπὸ τοῦδε ἐνέργειαν εἶναι ἕτερον τῷ λόγῳ. (202b5–15, b19–b22)

It is not absurd that the actualization of one thing should be in another. Teaching is the activity of a person who can teach, yet the operation is performed in something – it is not cut adrift from a subject, but is of one thing in another. There is nothing to prevent two things having one and the same actualization (not the same in being, but related as the potential is to the actual). Nor is it necessary that the teacher should learn, even if to act and to be acted on are one and the same, provided they are not the same in respect of the account which states their essence (as raiment and dress), but are the same in the sense in which the road from Thebes to Athens and the road from Athens to Thebes are the same, as has been explained above. For it is not

1. We will come back to this passage in more detail in sct. **??** on p. **??**.

things which are in any way the same that have all their attributes the same, but only those to be which is the same.
[…] To generalize, teaching is not the same as learning, or agency as patiency, in the full sense, though they belong to the same subject, the motion; for the actualization of this in that and the actualization of that through the action of this differ in definition. (Aristotle 2014: 763)

Or can it be that: (a) it is *not* absurd that the operation of one thing should be in another (for teaching is the operation of that which is disposed to teach, but it is *on* something, and not cut off, but is of this on this); and (b) there is, also, nothing to prevent the operation of two things being one and the same, not as the same in being, but in the way that what potentially is is related to what is operating, and (c) it is also not necessary that the teacher learns, even if to act upon and to be acted upon are the same thing, provided they are not the same in the sense that the definition that gives the 'what it was to be' is one (as with 'raiment' and 'clothing'), but in the sense in which the road from Thebes to Athens is the same as the road from Athens to Thebes, as was said earlier? For it is not the case that all the same things are present in things that are the same in any sense whatever, but only of those of which the being is the same.
[…] But speaking generally, the teaching is not the same, in the primary sense, as the learning, nor the acting-upon as the being-acted-upon, but that in which these things are present, namely the change, [is the same as being acted upon]; for to be the operation of *A* in *B*, and to be the operation of *B* by the agency of *A*, are different in definition. (Aristotle 1993: 5-6)

Even if *A* and *B* are the same in being, as long as they differ in form (in what it is to be an *A* and to be a *B*), they may manifest this formal difference without contradiction.

4.2 The nature of *kinêseis*

4.2.1 Powers, processes and events

4.2.2 The location of change

4.2.3 Change is of forms

There is an apparent tension between two Aristotelian claims:

- The 'variation' element in change is the pair of opposites; it is with respect to this pair of opposites, i.e. to form, that the starting-point of a change differs, and is opposed to, its end-point.
- Forms, including those forms involved in change, do not change – not because they are un-changing, as Plato thought, but because they are not the right kind of thing to be changeable at all.

Aquinas makes this quite clear in his commentary on *Physics* I.5:

Album enim non fit ex musico nisi forte secundum accidens, inquantum musico accidit esse album vel nigrum; sed album fit per se ex non albo, et non ex quocumque non albo, sed ex non albo quod est nigrum vel medius color: et similiter musicum ex non musico; et non ex quocumque non musico sed ex opposito, quod dicitur immusicum, idest quod est natum habere musicam et non habet, vel ex quocumque medio inter ea. (Commentaria in octo libros Physicorum, liber I, lectio X, §78, Leoninum edition)

For white does not come to be from musical except accidentally insofar as white or black happen to be in the musical. But white comes to be per se from the non-white, and not from just any non-white, but from that non-white which is black or some mean colour. And in like manner, the musical comes to be from the non-musical, and again not from just any nonmusical, but from its opposite, which is called the unmusical, i.e., from that which is disposed to be musical but is not, or from some mean between these two. (St. Thomas Aquinas 1999: ad loc.)

4.3 The Aristotelian infinite

The third book of the *Physics* started with the observation that "change is thought to be something continuous" (*suneches*, 200b17) and that it thereby has to to with the infinite (*to apeiron*. III.4 now distinguishes different senses of "infinite" and III.5 argues that there cannot be a self-subsistent infinite, while III.6 discusses the sense in which there can be, and is, a potential infinite, which III.7 characterises as derivative and with respect to which III.8 argues that it is not a principle.

4.3.1 Against the actual infinite

If there is such a thing as 'the infinite', then it is either a substance (as the Pythagoreans and Plato think) or *of* a substance (as the natural philosophers think). If it is a substance, we can ask a number of unanswerable questions about it:

origin If there is an infinite, where does it come from? It cannot come from anything (outside itself), so it must be a principle (*arche*).

composition If there is an infinite, what is it composed of? It cannot be itself divisible, but only insofar as it has a quantity; but then it is its quantity and not it itself that is infinite.

complexity If there is an infinite, does it have parts? If it has parts, and finitely many of them, some of them must be infinite themselves; this infinite part will then be both a proper part and identical to the whole (because it, too, is infinity), which is impossible. If it does not have parts, it is not infinite as a substance, but in some other way. If it has infinitely many parts, it is not itself infinite, but infinite-in-number. If the infinite is infinite-in-number only, then this number cannot be 'separated', i.e. "existing as the number of an actually realized totality" (Hussey 1993: 79), for such a number is essentially countable and it is impossible to count a number that is an infinite plurality of units, for each unit would have to be counted separately.

place If there is an infinite, where is it? The infinite cannot be a body, because bodies are essentially bounded ('formal' argument) and because such a body would have to be in a place. It cannot be in any place because such a place would have to be infinite and infinite places are impossible because we cannot characterise them in terms of above/below, left/right, forwards/backwards.

motion If there is an infinite, is it in motion or at rest? It cannot be in motion, for it takes up a place that is infinite in extent and so cannot change. It cannot be at rest, for to be at rest means not to be in some adjacent place.

4.3.2 The potential infinite

III.6 opens with the other horn of the dilemma: there must be an infinite, in some sense, and as an accident of things, because we cannot otherwise understand the series created by time, divisions of magnitudes (continuity) and number. He then says the following about the mode of being of the potential infinite:

ὅλως μὲν γὰρ οὕτως ἔστιν τὸ ἄπειρον, τῷ ἀεὶ ἄλλο καὶ ἄλλο λαμβάνεσθαι, καὶ τὸ λαμβανόμενον μὲν ἀεὶ εἶναι πεπερασμένον, ἀλλ' ἀεί γε ἕτερον καὶ ἕτερον· [ἔτι τὸ εἶναι πλεοναχῶς λέγεται, ὥστε τὸ ἄπειρον οὐ δεῖ λαμβάνειν ὡς τόδε τι, οἷον ἄνθρωπον ἢ οἰκίαν, ἀλλ' ὡς ἡ ἡμέρα λέγεται καὶ ὁ ἀγών, οἷς τὸ εἶναι οὐχ ὡς οὐσία τις γέγονεν, ἀλλ' ἀεὶ ἐν γενέσει ἢ φθορᾷ, πεπερασμένον, ἀλλ' ἀεί γε ἕτερον καὶ ἕτερον·] (206a27-206b3)

For generally the infinite has this mode of existence: one thing is always being taken after another, and each thing that is taken is always finite, but always different. [Again, 'being' is spoken of in several ways, so that we must not regard the infinite as a 'this', such as a man or a horse, but must suppose it to exist in the sense in which we speak of the day or the games as existing—things whose being has not come to them like that of a substance, but consists in a process of coming to be or passing away, finite, yet always different.] (Aristotle 2014: 776), adding "Ross excises the bracketed sentence as an alternative version of 206a18–29." (2014: 980)

In general, the infinite is in virtue of one thing's constantly being taken after another – each thing taken is finite, but it is always one followed by another; but in magnitudes what was taken persists, in the case of time and the race of men the things taken cease to be, yet so that [the series] does not give out. (Aristotle 1993: 14)

In III.7, Aristotle contrasts the two types of potential infinity he accepts. Number is infinite 'upwards', but not 'downwards': one / unity / 1 is indivisible, and numbers are pluralities of it and for any number, there is more. But there is no infinite number, and the infinity of arithmetical operators is not 'separable':

ἐπὶ δὲ τὸ πλεῖον ἀεὶ ἔστι νοῆσαι· ἄπειροι γὰρ αἱ διχοτομίαι τοῦ μεγέθους. ὥστε δυνάμει μὲν ἔστιν, ἐνεργείᾳ δ' οὔ· ἀλλ' ἀεὶ ὑπερβάλλει τὸ λαμβανόμενον παντὸς ὡρισμένου πλήθους. ἀλλ' οὐ χωριστὸς ὁ ἀριθμὸς οὗτος [τῆς διχοτομίας], οὐδὲ μένει ἡ ἀπειρία ἀλλὰ γίγνεται, ὥσπερ καὶ ὁ χρόνος καὶ ὁ ἀριθμὸς τοῦ χρόνου. (207b10-15)

But in the direction of largeness it is always possible to think of a large number; for the number of times a magnitude can be bisected is infinite. Hence this infinite is potential, never actual: the number of parts that can be taken always surpasses any definite amount.

But this number is not separable, and its infinity does not persist but consists in a process of coming to be, like time and the number of time. (Aristotle 2014: 780)

But in the direction of more it is always possible to conceive of [more] – since the halvings of magnitude are infinite. Hence [the infinite in number] is potentially, but not in actual operation, though what is taken always exceeds any deflnite multitude. But this number is not separable, and the inflnity does not stay still but comes to be, in the same way as time and the number of time. (Aristotle 1993: 17)

Quantity, by contrast, is infinite 'downwards', but not 'upwards': continuous quantities can be divided into infinitely many parts (and thus have these parts 'by division' potentially), but we cannot add infinitely many separate parts to anything and construct 'by addition' something which is actually infinitely big.

4.3.3 Beginningless time

Hussey (1993: xxv) describes Aristotle's "startling onclusion about the past" as follows:

> Straightforward realism about the past is no longer possible, since Aristotle holds that there was no beginning of time. He wishes therefore to say e.g., that there have been infinitely many yearly cycles of the sun before the present. But this cannot refer to a completed infinity. On his own account of infinity, it has to be true that, for some number n, there have been n previsous yearly cycles and there have not been, but could have been $n+1$ previous cycles. It is difficult to give any sense to this unless the past is in some sense a creation of the present. On such a view, the past is some thing created by memory and historical records in a lawlike fasion, just as the number series is something created by mathematical operations in a lawlike fasion." (Hussey 1993: xxv)

Chapter 5

Physics IV.1-9: Place and the Void

5.1 The ontology of places

We get, I think, a good grasp of the intellectual distance between Aristotle and us by noting that for Aristotle the existence of places, and the pressing need to give a philosophical account of them and their nature, follows just from the claim that at least some things are somewhere; and that, at the same time, uncovering the 'quantificational' character of the "…is somewhere" predicate does not commit us, by his lights, to treat places as *items* in our ontological inventory of what there is. To treat them as such would be to treat them as subjects (*hupokeimena*) or perhaps even as substances (*ousiai*).

5.1.1 The need for an account of place

Aristotle starts in IV.1 by noting an aporia with respect to place (*topos*) – where things are:

in favour: One thing can come to occupy the *same* place that was occupied by another thing before, so we should distinguish between a place and what occupies it. Places are not just where things are, but also where they go and where they come from. Places have dimensions and are extended in those.

against: Places are not bodies (*somata*), but share their dimensions. Place can be two-, one- or zero-dimensional: but can we similarly distinguish two-dimensional and zero-dimensional places from their occupants (surfaces and points)? What are places composed of, how are they causally active, where are they, can they change?

In IV.2 he notes, in addition, reasons for and against identifying it with either the form or the matter:

the form: Its place is where a thing is, what the thing is in, what surrounds the thing – so it is its form (*eidos*) or shape (*morphē*). But it cannot be its form, because it is separable from it (and can come to be occupied by something else).

the matter: The place where a thing is has a magnitude and is extended; what is extended and formed a certain way is matter (*hylē*). But place cannot be the matter of a thing if it surrounds and contains it (that is: its matter).

The place of a thing both surrounds it (*periechein*), i.e. "circumscribes [it] without including [it] as a component part" (Hussey 1993: 104), and is also coextensive with it. Because it surrounds, it is outside and cannot be its matter; because it is coextensive, it is extended and cannot be its form.

FROM HERE ON, THE STUFF IS IN "ARISTOTLE-PLACE.TEX"

5.1.2 Places as what is changed in motion

"ARISTOTLE-PLACE.TEX"

5.1.3 Inner and outer boundaries

"ARISTOTLE-PLACE.TEX"

5.2 The superiority of Aristotle's account of places

INTRO

5.2.1 Places as derivative

Aristotle's account of places as derivative, lower-dimensional limits of bodies has some interesting consequences:

"ARISTOTLE-PLACE.TEX"

5.2.2 The location of places: places are not shadows

"ARISTOTLE-PLACE.TEX"

5.2.3 The location of the universe and its rotation

"ARISTOTLE-PLACE.TEX"

5.3 Nine arguments against the possibility of void

TO BE DONE

5.3.1 There cannot be void around things

5.3.2 There cannot be void within things

5.3.3 The world as a plenum

Chapter 6

Physics IV.10-14: Time

6.1 Time and change

As with space, Aristotle starts his discussion of time with a consideration of reasons for and against its existence. The considerations against it are the following:

Passing away If there is time, some of it has been and is not, and some will be and is not. So if there is time, some parts of it are not.

Constitution Time is complex and a whole, but it never (i.e. at no time) has all its parts, it never *is* the whole they compose.

Extension Time is temporally extended, but the only part of it that is (and hence the only part it has, for to have a part that part must exist) is an unextended instant, and an instant, lacking temporal extent, cannot make up time.

Change Time is dynamic, it passes, but it is difficult to see how the only part of it that exists – the present – may be said to change at all.

The present For time to pass, the present must recede; but it cannot pass into utter non-existence, because there is some time that is past; to say, on the other hand, that it recedes (only) in the sense of stopping to be present, is not saying anything, because it cannot be present at any other time than it is. Neither does it help to say that the present is extended, because then it has two boundaries, and only one of them can be the present.

These are difficult problems: even if time exists – and this, after all, we have presupposed when we have presupposed that there is change – it seems a rather strange beast. One thus understands why some may want to say that time, if it exists at all, exists only "dimly" or "barely".

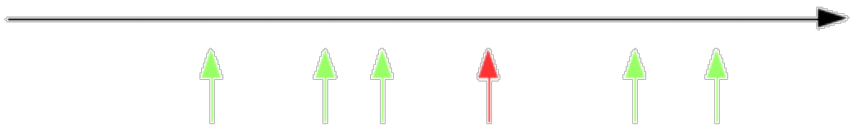
The contrary case, that there is time, is made only cursorily. This may have two reasons: we may, if not of all then certainly of many things, ask when they are – so there is a time at which they are, so there are times and there is time. We have also presupposed at the outset that there is change, and change is always in time.

If there is time because there is change, however, can we identify the two? Aristotle considers several ways to do and concludes that we cannot. Time could be change in the sense of being the thing that (primarily) changes, e.g. the revolution of the universe. If this is a thing, however, then it does not change (and there could be several of it); if it is a process, then it does change, but *within* time, so it cannot *be* itself time. Time could be change in the sense of being identical to each and every alteration: but these are in the things that change, and time is not; they are fast or slow, and thus in time in different ways, but time cannot be faster or slower than it is.

6.1.1 No time without change

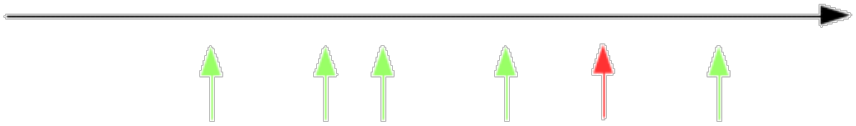
With time, we have, at least, a double problem. The first one concerns the **reality** of time: to be real, time must be temporally extended and it is difficult to see how it can be. This problem is the problem of what Aristotle calls

"the before" (*to proteron*) and "the after" (*to husteron*), of instants that are past or future (green arrow) in relation to the one instant that is the present (red arrow):



In what sense is time 'made up' of all these instants, what ontological status have the green ones, in what sense are they part of time? We want to say, of course, that some of them *will* be red and others *have been* red – but as in the case of the problem of change, the difficulty is to see why saying this should help.

The other, correlative, but distinct problem concerns the **passage** of time. Not only does time extend into non-being, but it also changes with respect to it; it passes and things that were future become present and then past. This is the problem of understanding the difference between the situation pictured above and the following:



The two situation do not differ in their ontology, one might say, they depict the same elements; but they depict them differently, and as differently: between the first and the second situation, time has 'moved on', and brought about a change in which of the instants is present. But how can that be?

After having concluded in IV.10 that time is not the same thing as change, Aristotle reconsiders their intimate relationship in IV.11. The first link is epistemological: it is our own undergoing of change that makes us notice change. I find it plausible to assume that for Aristotle there is even a tighter link. Noticing change is undergoing change oneself: I cannot see the cat moving, e.g., if I do not see it differently at different times. When there is change in my perception, I always notice it (though perhaps not all of it): seeing a difference is seeing things differently and this difference is itself (part of what is) seen.[1]

Aristotle concludes from the epistemological link that time and change stand in a relation of ontological dependence, that even though time is not identical with change, it is not 'separable' from it either, that time is an 'aspect' of change. This explains, in his view, the mutual dependence of their perceptions: time and change are "perceived together". Being an aspect of change, time inherits the extrinsicness of some of its essential properties. A change is e.g. said to be continuous because it is a change in a continuous magnitude. The time of that change, which itself is of the magnitude, is thus continuous for the same reason: because the magnitude in question is continuous.

Our perception of time thus has a quite different epistemological status than our perception of e.g. stones. Temporal experience is, if it is of temporality, i.e. change, necessarily itself temporal, i.e. changing: to say of a given clock that it runs fast or slow, goes more or less quickly or that it has stopped, *is* to say these things of the given clock in relation to another one that is 'held steady'. We do not need a 'clock' in the normal sense of the word to do this:[2] any regular process, e.g. (normally) our heart-beat will do – "regular", of course, itself being a relative temporal qualification. We measure temporal change in relation to temporal change; there is no 'outside perspective' on time at all.

These remarks about the centrality of time measurement are followed by a difficult passage, where Aristotle discusses whether the same can be said of the dimensionality of time:

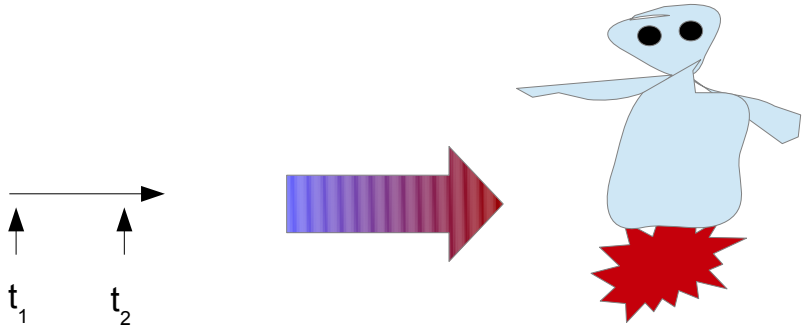
1. This does not mean that Aristotle here has to postulate an introspective faculty, which monitors the perceptions (perceives them?) and notices their difference. Difference may be 'given' in perception in other, cognitively less demanding ways, as when we see something surprising – we are surprised to see this (pupil dilated, startled), but for this it is not necessary that we see something *as* surprising.
2. Indeed, it appears quite doubtful that there is such a thing: "clock" does not appear to be a semantically unified concept at all.

τὸ δὴ πρότερον καὶ ὕστερον ἐν τόπῳ πρῶτόν ἐστιν. ἐνταῦθα μὲν δὴ τῇ θέσει· ἐπεὶ δ' ἐν τῷ μεγέθει ἔστι τὸ πρότερον καὶ ὕστερον, ἀνάγκη καὶ ἐν κινήσει εἶναι τὸ πρότερον καὶ ὕστερον, ἀνάλογον τοῖς ἐκεῖ. ἀλλὰ μὴν καὶ ἐν χρόνῳ ἔστιν τὸ πρότερον καὶ ὕστερον διὰ τὸ ἀκολουθεῖν ἀεὶ θατέρῳ θάτερον αὐτῶν. ἔστι δὲ τὸ πρότερον καὶ ὕστερον ἐν τῇ κινήσει ὃ μέν ποτε ὂν κίνησις [ἐστιν]· τὸ μέντοι εἶναι αὐτῷ ἕτερον καὶ οὐ κίνησις. (219a14-21)

The distinction of before and after holds primarily, then, in place; and there in virtue of relative position. Since then before and after hold in magnitude, they must hold also in movement, these corresponding to those. But also in time the distinction of before and after must hold; for time and movement always correspond with each other. The before and after in motion identical in substratum with motion yet differs from it in being, and is not identical with motion. (Aristotle 2014: 820)

Now the before and after is in place primarily; there, it is by convention. But since the before and after is in magnitude, it must also be in change, by analogy with what there is there. But in time, too, the before and after is present, because the one always follows the other of them. The before and after in change is, in respect of what makes it what it is, change; but its being is different and is not change. (Aristotle 1993: 43–44)

Aristotle here discusses the difficult question if, and if so, in what sense, we can attribute temporal qualifications to time itself and wants to exhibit a way in which we can. It was said earlier that it makes no sense to talk of "time in time", i.e. to say of some part of time, e.g. the present, that it was future and will be past. Every time is essentially the time it is and could not be at any other time, for that would mean that it were another time. As an aspect of change, which is a change in some intrinsically ordered 'pair of opposites', e.g. the continuum from hot to cold, time may indirectly be said to exhibit temporal order. Let us picture Socrates sitting by the fire, warming up:

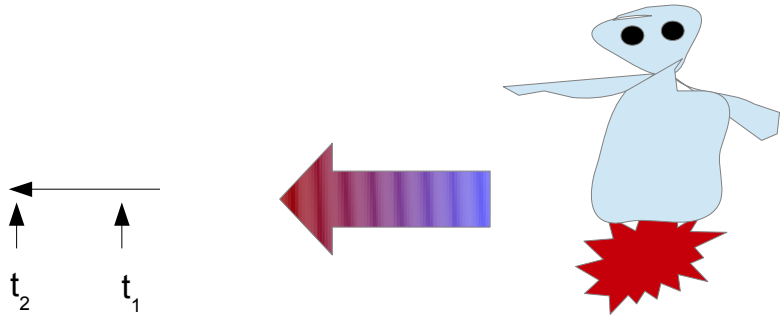


We have a change, of an underlying thing (Socrates), between a pair of opposites, i.e. from cold to warm. This change is a change in magnitude: it is between a lower point in the temperature dimension (depicted in the middle) and a higher point in that dimension. It is also directed: it is from cold to hot and this is why it is a warming-up, rather than a cooling-down of Socrates. Saying that it is a warming-up, however, is *already* saying that the process is temporarily directed, that the lower point in temperature is *before* the higher point, which is *after*.

Aristotle discusses here the ontological status of the green arrows in the first picture above and asks what it means to call them "before" and "after" respectively. He answers that these denominations mark the inner temporal structure of a process which is intrinsically directed, i.e. which is a change *from* one of two opposites *to* the other.

The change is from the cold to the hot (and thus a different change than the change from hot to cold would be), and gives the magnitude a 'before' and 'after' structure: *before* the warming up, Socrates was cold, and *after* it, he is now warm. Time, because it is an aspect of this change, inherits this structure: the time when Socrates was cold may be said to be *before* the time when Socrates is warm, even though the times themselves have not receded into the past.

The temporal characterisation of what is happening with Socrates is in this way derivative on and posterior to the process we are observing: it is *because* this process is a warming up that t_1 is related to the blue end of the arrow and t_2 is related to the red end of the arrow. If they were differently related (t_1 to red and t_2 to blue), the process would be a cooling-down. That the two instants are so related is all there is about them: nothing in the situation makes it impossible that it could also be pictured this way:



This is the same picture because the intrinsically temporally directed process is the same: the earlier instant is still associated with the blue end of the arrow, the later instant with the red end. The situation, of course, would be different if we changed only one direction of the two arrows: we would then depict a cooling-down rather than a warming-up.

In the last sentence of the quoted passage, Aristotle addresses the question of the ontological status of non-present instants, saying that they are not different in number or reality from the ongoing process: they are what makes that process what it is (i.e. a warming-up, rather than a cooling down): they are its moments, but they differ from it in being or in account. What is is to be a process of warming up is not the same as what it is to be an instant of high-temperature (nor what it is to be an instant of low-temperature). What it is to be the before and the after is for the instants to be related in some way to different stages of that process, not what it is to be these different stages.[3]

But what exactly is it what we do when we describe a intrinsically temporally structured process in terms of the before and the after, two instants differing not in reality but only in being? To temporally locate the successive parts of a process, we 'clock' them, i.e. we notice their passing by marking off two 'nows':

ἀλλὰ μὴν καὶ τὸν χρόνον γε γνωρίζομεν ὅταν ὁρίσωμεν τὴν κίνησιν, τῷ πρότερον καὶ ὕστερον ὁρίζοντες· καὶ τότε φαμὲν γεγονέναι χρόνον, ὅταν τοῦ προτέρου καὶ ὑστέρου ἐν τῇ κινήσει αἴσθησιν λάβωμεν. ὁρίζομεν δὲ τῷ ἄλλο καὶ ἄλλο ὑπολαβεῖν αὐτά, καὶ μεταξύ τι αὐτῶν ἕτερον· ὅταν γὰρ ἕτερα τὰ ἄκρα τοῦ μέσου νοήσωμεν, καὶ δύο εἴπῃ ἡ ψυχὴ τὰ νῦν, τὸ μὲν πρότερον τὸ δ' ὕστερον, τότε καὶ τοῦτό φαμεν εἶναι χρόνον· τὸ γὰρ ὁριζόμενον τῷ νῦν χρόνος εἶναι δοκεῖ· καὶ ὑποκείσθω. (219a22-30)

But we apprehend time only when we have marked motion, marking it by before and after; and it is only when we have perceived before and after in motion that we say that time has elapsed. Now we mark them by judging that one thing is different from another, and that some third thing is intermediate to them. When we think of the extremes as different from the middle and the mind pronounces that the 'nows' are two, one before and one after, it is then that we say that there is time, and this that we say is time. For what is bounded by the 'now' is thought to be time – we may assume this. (Aristotle 2014: 820)

But time, too, we become acquainted with when we mark off change, marking it off by the before and after, and we say that time has passed when we get a perception of the before and after in change. We mark off change by taking them [the before and after in change] to be different things, and some other thing between them; for whenever we conceive of the limits as other than the middle, and the soul says that the nows are two, one before and one after, then it is and this it is that we say time is. (What is marked off by the now is thought to be time: let this be taken as true.) (Aristotle 1993: 44)

Aristotle here makes the step from temporal perception to perception of time and to what it is we then perceive, i.e. time itself. What the step exactly consists in is difficult to say. Here is an attempt: The marking-off is done by us, functioning as a clock, and it is done by positing one identical mark – the 'now' – twice in succession, marking two boundaries and thus an interval, i.e. (part of) what time is. What we judge to be different from one another are the two instants which are identical in number but different in being. The way we judge this is by 'marking off' two 'nows'. We can do this, while watching the cat move or Socrates warming up, by saying "now" and "now". By saying that we say the "same thing" twice, we automatically say that we say it at different times, and so that we 'mark off' different instants.[4] As these two instants do not differ intrinsically, however, we cannot but 'mark' them 'off' in the same way, by "now" and we are right in doing so (they are present when we ? mark' them 'off', after

3. Perhaps a way of making sense of this is the following: the temporal qualifications qualify directly only the magnitude, and only indirectly the process.

4. We can make this explicit by saying "Socrates is warming up" first, and "Socrates has warmed up" later – we would still have said, in a sense, the same thing twice. We will return to this point later.

all). They are both nows and differ only in that the one is 'marked off' *as* the before and the other one is 'marked off' *as* the after.

What we 'mark off' in this way *is* time. We thus get the famous account of time as the number (measure, rate) of change:

τοῦτο γάρ ἐστιν ὁ χρόνος, ἀριθμὸς κινήσεως κατὰ τὸ πρότερον καὶ ὕστερον. οὐκ ἄρα κί νησις ὁ χρόνος ἀλλ' ᾗ ἀριθμὸν ἔχει ἡ κίνησις. σημεῖον δέ· τὸ μὲν γὰρ πλεῖον καὶ ἔλαττον κρίνομεν ἀριθμῷ, κίνησιν δὲ πλείω καὶ ἐλάττω χρόνῳ· ἀριθμὸς ἄρα τις ὁ χρόνος. ἐπεὶ δ' ἀριθμός ἐστι διχῶς (καὶ γὰρ τὸ ἀριθμούμενον καὶ τὸ ἀριθμητὸν ἀριθμὸν λέγομεν, καὶ ᾧ ἀριθμοῦμεν), ὁ δὴ χρόνος ἐστὶν τὸ ἀριθμούμενον καὶ οὐχ ᾧ ἀριθμοῦμεν. (219b1-9)

For time is just this – number of motion in respect of 'before' and 'after'. Hence time is not movement, but only movement in so far as it admits of enumeration. An indication of this: we discriminate the more or the less by number, but more or less movement by time. Time then is a kind of number. (Number, we must note, is used in two ways – both of what is counted or countable and also of that with which we count. Time, then, is what is counted, not that with which we count: these are different kinds of thing.) (Aristotle 2014: 821)

For that is what time is: a number of change in respect of the before and after. So time is not change but in the way in which change has a number. An indication: we discern the greater and the less by number, and greater and less change by time; hence time is a kind of number. But number is [so called] in two ways: we call number both (a) that which is counted and countable, and (b) that by which we count. Time is that which is counted and not that by which we count. (Aristotle 1993: 44)

The two marks by which we mark off an interval are in one sense the same and in one sense different: they are the same in reality and in number, because they are both borders between the past and the future, and what it is to be such a border ('whatever it is that makes it a now') is thus the same. Though the now remains numerically the same, it undergoes a change (it is the underlying thing of the change which is the passing of time): the two 'nows' are different in definition ('their being is not the same') because each of them is the now *of* something changing, and what it is to be that changing thing changes during (and because of) the change.

The being of the now changes from before to after (i.e.: it was the before, and becomes the after), and it is this difference in being that is counted by our marking off the two respective instants.

6.1.2 Time is a number

If he could have heard Aristotle saying that time is a number, Plato would probably have felt vindicated: what good is it building your whole philosophy around the assumption that there is change, if you end up saying that time, indispensable for and inseparable from change, is an abstract mathematical object, unchanging and absolute? To not give Plato such shallow satisfaction, it is very important for Aristotle to be able to say that time is a number only in a sense. But in which sense? This question is answered in the last sentence of the quote above: While time is a number and numbers essentially are for counting, it is not that by which we are counting but that which is counted.

Number words, in Greek, English and any other language I know of, are systematically ambiguous between a predicative and a noun-use. When I say that there are three horses, I say that their number is three, and vice versa: in its first occurrence, however, "two" was qualifying predicatively the horses (collectively, of course, not individually), while in its second occurrence, it stands for that thing which is the number two. At least for "one", the first use is marked in many languages by gender: I cannot say "ein Frau" or "un femme", even though the number of women (salient in a certain context) may be said to be "eins" (German even uses a noun that is syntactically different from the male number predicate) or "un". In its second meaning, "two" stands for what we count by (the number), in its first for what we are counting (the horses).

The two uses of number words are connected, however: when I say that there are two (flowers, say), I am numbering them by "two", but also saying of their number (two) that it is two. I am counting them, but also their number. What I am counting are units, one horse and then another horse: the units are the same (what it is to be one for the first horse is what it is to be one for the second horse), but I am counting them/it twice, so in this sense I am counting two units, i.e. am counting to two, i.e. am counting the number of the two horses.

What we mark off when we measure time are nows, and time is the number of them, i.e. a measure of how many of them there are (counting by difference in being, not by numerical difference). The length of what we mark out

is recurring ("we've been waiting for him again for five minutes"), even though what is recurring (this five minute wait, that five minute wait) is not: it is not recurring identically, as it were, but only with respect to its length.

6.1.3 Continuity

Because the 'now' is extrinsically individuated by the thing it is the border off, there would be no 'now' in an instantaneous or atemporal universe: there would be no 'now' if there were no time and there would be no time (nothing counted) if there were no now.

6.2 The reality of time

What kind of reality does "time is the number of change" attribute to time? Hussey, along with many others, takes Aristotle to think that time is a *quantity*:

> Aristotle's thought is that (roughly) there is nothing more to time tna that it is a measurable quantity which attaches to changes in just the same sort of way as e.g. length and heaviness attach to material bodies. There is, in particular, no unified, all-embracing, self-subsistent 'Time': there are just changes having greater and lesser quantities of time-length. (Hussey 1993: xxxviii)

While I agree with the second assertion, the first one is straightforwardly false: Aristotle does *not* say that time is a quantity or magnitude, but says that it is the number, i.e. a measure of some such quantity or magnitude.

6.2.1 Two different nows

6.2.2 Ways of being in time

6.2.3 The infinity of time

6.3 Measuring and counting

6.3.1 Sortal-relativity

6.3.2 Aristotle's structuralism

6.3.3 Time as a number

Chapter 7

Physics V+VI: Motions

7.1 The change that is motion

Physics V.1 distinguishes three ways in which one and the same change may be described:

accidental change (*kata sumbebekos*): the musician walks, who happens to be Socrates – a change of the musician, but which happens to be *of* the musician (rather than of a non-musician) only accidentally;

intrinsic change (*kath'auto*): the body is healed because the eyeis healed – a change of the body, which it undergoes in virtue of a change in one of its parts;

essential change: a thing becomes actually what is was potentially – the body which is capable of being healed is healed and thus realises the potentiality it has.

It is the third type of transition that is directly attributed to the thing underlying the change – the matter changing from one opposite to the other – and the change is 'named' after its end-point: after "warm" if it is a warming-up and after "cold" if it is a cooling-down. This 'endpoint', a form, is not itself changed in the change.

A change from a non-subject to a subject is a coming-to-be (*genesis*). If the change is between opposites, what comes to be is a so-called 'accidential unity', white Socrates or a musician. If the change is from unqualified non-being to being, what comes to be is a self-standing Aristotelian substance, e.g. a house. A change from a subject to a non-subject is a ceasing-to-be ("perishing", *phthora*), either of accidential unities or of substances. Changes between subjects are the third category, and every motion (*kinesis*) is such a change from subject to subject, i.e. neither a coming-to-be nor a ceasing-to-be.

Change in the category of quality is alteration (*alloiosis*), change in quantity is increase (*auxēsis*) or decrease (*phthisis*), change in place is

7.1.1 Types of change

In V.2, Aristotle considers the question whether there can be change of change and argues that there can only be accidental change of change. For the conclusion that there cannot be non-accidental change of change, he offers four arguments:

- change requires a subject / underlying thing, and change is no such thing;
- if there were (genuine) change of change, change would never start: for it would have to change first in order to start, i.e. undergo a change which itself would have to change to start etc.;
- a problem at the level of potentialities: if a becoming-to-be would also be a ceasing-to-be, it would have to have the potentiality to cease-to-be; to have this potentiality, it would have to exist; but if it already exists, it cannot have the potentiality to become-to-be;[1]

1. The analogue for non-substantial change is less plausible: if a darkening would also be a whitening, it would have to have the potentiality to become white; to have this potentiality, it must be dark; but if it already is dark, it cannot have the potentiality to become dark.

The cases of accidential changes of changes he has in mind seem to be 'pendulum' changes, as when someone gets sicker and sicker, reaches a turn point and then becomes healthier again. Changes between substances are from one form to another and the 'accident' involved at the turning point is that the opposite which is the end-point (sickness) is concurrent with its opposite (health) being present in potentiality.

V.3 defines a number of terms that, while themselves topic-neutral, will be applied to both time and change, starting with the most general and primitive one: being in succession. Something *a* is said to be "in succession" if it is after / succeeds something *b* and does so directly, i.e. without having anything of the same kind as *a* between *a* and *b*. Something which is in succession and in contact with what it succeeds is said to be "contiguous". Two things are said to be "in contact" if their extremities are together, i.e. in one primary place.

Something contiguous is said to be "continuous" if it not only is in contact ("touches") the thing it succeeds but "the touching limits of each become one and the same and are, as the word implies, contained in each other" – i.e. if it shares its border (that by which it is in contact with the thing it succeeds) with the thing it succeeds.

7.1.2 The unity of motion

V.4 discusses identity criteria for types and tokens of motions: two motions are type-identical if they are of the same of the three types ("one generically") and if they belong to the same lowest species with respect to their pair of opposites ("specficially one").

Two token motions of the same type are identical ("one in an unqualified sense") only if they are the same in three respects:

that which: they have the same underlying thing;
that in which: they have the same medium;
that during which: they take up the same time.

With respect to the question whether token motions are repeatable, Aristotle explores both possibilities. If we are happy to accept intermittent existence, we can say that Socrates undergoes the very same alteration twice; if not, not.

7.1.3 The nature of *steresis*

In V.5, Aristotle distinguishes different ways in which changes may be opposed to each other. If *A* and *B* are contraries (e.g.: warm and cold), the following may be said to be contrary motions:

1. from *A* and to *A*
2. from *A* and from *B*
3. to *A* and to *B*
4. from *A* and to *B*
5. from *A* to *B* and from *B* to *A*

He first excludes case (4): these are not really contrary, for they are the same in number and reality, and differ only in account. By the same reason, cases (2) and (3) are really just one phenomenon; and it is in turn the same as (5) and (1), for the motion to *A* is always, mediately or immediately, from *B* (and vice versa).

In V.6, states of rest (*hēremia*) are characterised as contraries of motions, in the following way:

- resting in *A* is the contrary and privation of the motion from *A* to *B*
- resting in *B* is the contrary and privation of the motion from *B* to *A*

They inherit their contrariness from the motions they are privations of: just as the motion from *A* to *B* is contrary to the motion from *B* to *A*, so it the rest state *A* to the rest state *B*.

7.2 The instant of change

In VI.1, Aristotle draws some surprising consequences out of the seemingly innocent definitions of topological terms in book V.3.

Everything that is not scattered must be gunky ("nothing continuous can be composed of indivisibles").

Because motion is gunky, so must be the magnitude within which it moves, the time during which it moves and the thing that is moved by it. The reasoning is *per absurdum*: if any of these was composed of indivisibles, motion would have partless parts.

The connection between the continuity of motion and of time is then exploited to solve Zeno's paradox of the runner in VI.2

Aristotle first gives an argument that time is continuous

and so is magnitude

Everything continuous has parts

7.2.1 What can happen in an instant

It was asserted already that the present (*to nun*) does not have parts. That time is continuous now allows to fill in a missing premiss in the argument given earlier. The argument was:

1. The present is the boundary of the past.
2. The present is the boundary of the future.
3. If these two boundaries were different, they would be apart from each other, and there would be time intermediate between them.
4. This intermediate time would be divisible, and so the present itself would be divisible.
5. The present would be divisible *in time*, so part of it would be in the past and part of it in the future.
6. But then it could not be the boundaries it is.

Because the present is also in time, time contains an indivisible part.

From the indivisibility of the present it follows that there cannot be instantaneous motion, nor instantaneous rest.

In VI.4, Aristotle argues that every change is temporally divisible, and that every change is divisible into sub-changes.

Aristotle next (VI.5) addresses the problem of the starting-point of a change. If something changes from A to B, it ceases to be A at the start of the change. So what is it while it is changing? B, Aristotle answers.

To make this palatable, Aristotle distinguishes the ongoing of a change from its completion.

Changes do not have starting-points, nor do they have a first stage.

7.2.2 The progressive paradox

Every change has a 'primary time', i.e. an exact duration, and it fills it in the sense that it happens at every part of it. Because time is infinitely divisible, so is change: whenever something is changing, it has been changing before.

VI.7: There cannot be a finite motion in an infinite time, nor can there be an infinite motion in a finite time.

VI.8: Rest.

In VI.9, Zeno's arguments against the possibility of motion are addressed. Aristotle ascribes to him four:

Bisection
Achilles
the flying arrow
Race-course

VI.10 argues that the quantitatively indivisible can only move *per accidens*, by being a part of something that moves.

7.2.3 The 'at-at' theory of velocity

7.3 Answering Zeno

7.3.1 Zeno's arguments

7.3.2 The Aristotelian continuum

7.3.3 Infinite motion

Chapter 8

Physics VII+VIII: Movings, the First Motion and the First Mover

INTRO

8.1 *Physics VII*: A first stab

get on book 7, in biblio: Wardy (1990)

8.1.1 The regress of motions

At the very start of VII.1, Aristotle gives a somewhat curious argument for the conclusion that everything moving is moved by something else than itself. Let a be something that moves, and "p" abbreviate the desired conclusion that a is moved by something different than a:

1. If it is not the case that a has the source of its motion in itself, then p.
2. Let us suppose a has the source of its motion in itself.
3. A sufficient condition for a is moved by b: necessarily, if b were to stop ("cease from its motion"), then this would cause a to be at rest.
4. a has a proper part, c ("everything that is in motion is divisible").
5. If c were not in motion, then a would not be in motion, or at least it would not be in motion "essentially and primarily".
6. So a is moved by c, hence p.

From the irreflexivity of "…is moved by …", Aristotle argues for the existence of a first mover:

P1 Nothing moves itself.
P2 Something, a_1, moves.
P3 Whatever it is that moves anything, must also be in motion.
C1 a_1 is moved by a_2, which is moved by a_3, etc. a_n being moved by a_{n+1}, the series is infinite. (from P1-P3)
P4 The motions of all members of the series are simultaneous.
C2 Each motion of a member of the series lasts for the same (amount of) time than the motion of a_1. (from P4?)
C3 The motion of the whole series is infinite, because it contains infinitely many numerically different sub-motions. (from C1 and C2)
P5 There can be infinite motion in a finite time only if it is done by (or, at least, is attributable to) many things.
P6 Being moved by something requires being either in contact with it or continuous with it.
C4 All members of the series are in contact or continuous with each other. (from C1 and P6)
C5 Hence they are not "many things" in the sense of (P5). (from C4)
C6 The time of the motion of the whole series in finite. (from C2?)

We derive a contradiction and have to deny one of the premisses. Aristotle thinks that we should deny (P_3) and stop the regress with a first mover which is unmoved.

There are, of course, plenty of gaps in the argument. Here are some of them:

- It does not follow from the irreflexivity of "…is moved by …" that there may not be circles, i.e. that there may not be some $i < n$ such that a_n is moved by a_i. This violates reflexivity only if the relation is also transitive and if for every thing in the series there is just one thing it is moved by.
- It is not clear why we should think that the combined motion of the series takes up a finite time (or even the same time as motion of a_1, as Aristotle seems to think).
- What justification is there for (P_5)? Will not (P_5) lead to Zenonian paradoxes?

In VII.2, Aristotle explicates the requirement that for a to move b, a and b have to be 'together' (*to hama*) or in contact (*to haptomenon*), for the three types of motion:

local, i.e. wrt place if b's locomotion is 'from a', a imparts it and so a must be adjacent to b. There cannot be something in between a and b, because a is changing b's position with respect to its own place (pushing it away or pulling it towards it)

qualitative if b's alteration is 'from a', then, because b's alteration could occur in animate things, a is a sensible thing that changes the sensible characteristics of b or their degree. If a changes b's sensible characteristics, it is either continuous with it (via air in hearing and smelling, via light in sight) or adjacent to it (as the flavour is in tasting).

quantitative if b's increase/decrease is 'from a', a either starts the increase by becoming attached to b and one with b or a starts the decrease by being a part that becomes detached from b, and in both cases a is continuous with b.

8.1.2 Regresses and types of well-foundedness

STILL TO COME, FROM THE "BEING WITHOUT FOUNDATIONS" PROJECT

8.1.3 Alterations

VII.3 is a defense of the presupposition made just before in VII.2 that alteration is always 'from' sensible things, and only of things that are "said to be essentially affected by sensible things". The argument is, at first sight at least, a blatant non-sequitur. Aristotle discusses two cases of change, argues that none of them are alterations and notes that, in many cases at least, changes of the second kind (acquisitions of states of the soul) occur in sensible things, more particularly in the sensitive part of the soul, concluding from this that alterations always occur, except accidentally, only in the sensitive part of the soul.

- When form or figure are changed, this change is not an alteration. When the bronze is sculpted into a statue, or the wood into a bed, this is not a qualitative change, attributable to the wood or the bronze. Rather, we have a bronzen statue and a wooden bed. When a quantity of iron is melted into a bronze and changes its figure, this is also no qualitative change, attributable to the hot fluid. Rather, we now have bronze (and not just iron in a different shape). In substantial change generally, what comes into being is not altered (changed qualitatively), and the coming into being is not an alteration, even if there is an underlying thing (which perhaps necessarily there is).
- The acquisition of a state is also not an alteration, for the state is either perfect or less than perfect and more or less corrupt. If it is perfect, its acquisition is not gradual: only the endpoint is the perfect state. If it is less than perfect, it falls short of its thing's nature and this is again not a gradual transition, but a binary change from perfect to less-than-perfect. This binary change depends upon particular relations to other things, and whether or not these relations hold is a yes-no question, even when alterations in the other relata are necessary for the relation to hold.

VII.4 discusses the commensurability of motions. and notes first that local, qualitative and quantitative changes are pairwise incommensurable, for lengths (of local mouvements), affections (of qualitative change) and magnitudes

(of quantitative change) cannot be equal to each other. With respect to locomotion, he discusses at some length what diagnosis can be given of the (assumed) incommensurability of the length of a straight and the length of a circular line. To assess questions of commensurability of motions of a given type (local, qualitative or quantitative), we have to divide the type into species, and these species are derivable from the species of things that undergo these motions naturally and primarily.

For alterations (qualitative changes), this recipe is applied thus: a becoming white and a becoming healthy cannot be compared with respect to their speed because WHITE and HEALTH are specifically different, i.e. differ as species (of affections).

VII.5 observes that among motive force, restive force (e.g. weight), time and distance, the last three are pairwise directly proportional to each other, but that motive force is not, as it is subject to a threshold principle: it must be of some quantity to be able to move at all. The same is then said to be true of alteration: the amount, the extent of alteration and its time are pairwise proportional (half the alteration in half the time; alteration of half the object in half the time; half the time for half of the alteration or for alteration of half of the object; double the alteration for half of the object; half of the object altered for half of the alteration), but this does not hold for that which causes the alteration: it must be active or become activated beyond a certain threshold to cause any alteration at all.

8.2 A fresh start: *Physics* VIII

8.2.1 The eternity of motion

In VIII.1, Aristotle argues for the eternity of motion: that there always were things moving. The starting point is an instance of the general definition of change (*Phys.* III.1 201a10-11), specialised to the special case of motion, and the observation that, even as actualised, a potentiality is always a potentiality *of* something:

φαμὲν δὴ τὴν κίνησιν εἶναι ἐνέργειαν τοῦ κινητοῦ ᾗ κινητόν. ἀναγκαῖον ἄρα ὑπάρχειν τὰ πράγματα τὰ δυνάμενα κινεῖσθαι καθ' ἑκάστην κίνησιν. (251a8-12)	Motion, we say, is the actuality of the movable in so far as it is movable. Each kind of motion, therefore, necessarily involves the presence of the things that are capable of that motion. (Aristotle 2014: 921)	Now we say that motion is the actuality of the movable in so far as it is movable. It is necessary, therefore, that there should be objects which are able to move with each kind of motion. (Aristotle 1999: 2)

To show the eternity of motion, Aristotle proceeds to show that the coming to be of motion "implies a change previous to the first motion", which is absurd:

P1 If there is motion, there must be something movable.
P2 If the movable does not exist eternally, it came into being.
P3 If it came into being, then this coming to be itself was a change or a motion (*metabolē* or *kinesis*), prior to the motion in (**P1**).
P4 The movable cannot exist eternally and always be at rest, for rest is the privation of motion and in need of a cause (*aition*).
P5 So if the movable did not come into being, it was either already moving or it came to be in a state of rest, in both cases by a motion prior to the motion in (**P1**).
C In both cases, there was motion before the motion in (**P1**).

(**P4**) is widely regarded as the least plausible premise:[1] it says that we need a cause for the fact that the potential of the movable to move was not activated before. It is true that Aristotle does not in general require causes for states of rest (and instead accepts the absence of a cause for motion as a sufficient explanation),[2] but the situation here is special, because we are inquiring about the possibility of some movable's rest-state that has no beginning in time. That this is impossible will Aristotle try to show next: the only thing that could have prevented the movable from moving from eternity is a lack of 'contact'; overcoming such a lack of 'contact', however, requires motion, so

1. Graham (1999: 43) calls it "the most puzzling step".
2. This is why Graham (1999: 43) feels obliged to add an extra premise: "There must be some change to cancel to cause of [the mover's] being at rest" – "the need for a cause to eliminate the obstacle or to 'turn on', as it were, [the movable]". But not only is this premise not needed, it is also not Aristotelian: Aristotelian powers, as we have seen, do not need to be 'turned on'.

there must have been a prior motion to bring the movable into contact with its 'manifestation partner', to produce motion. For there to be motion, there has to be contact, and this itself has to be brought about by a prior motion. This is said, in so many words, in 251a28-b10:

ἀλλ' οὖν ὅσα γε δυνατὰ ποιεῖν καὶ πάσχειν ἢ κινεῖν, τὰ δὲ κινεῖσθαι, οὐ πάντως δυνατά ἐστιν, ἀλλ' ὡδὶ ἔχοντα καὶ πλησιάζοντα ἀλλήλοις. (251b1-b3)

But at any rate all things that are capable of affecting and being affected, or of causing motion and being moved, are capable of it not under all conditions, but only when they are in a particular condition and approach one another…(Aristotle 2014: 922)

But things that are able to act or to be acted on, or to move things and be moved, respectively, are not able to interact under any condition whatsoever, but only if they are in a certain condition and approach each other. (Aristotle 1999: 2)

So perhaps we can grant Aristotle (**P4**). (**P3**), however, is perhaps even more problematic: while becoming-to-be certainly counts as a 'change', why should we take it to be *kinesis* in the sense of the type of thing of which the argument is supposed to show that there cannot be a first one?

The second argument infers the eternity of motion from the eternity of time:

P1 If time has come to be, it has come to be at an instant. ("Time cannot be thought of apart from the now." / *adunaton estin kai einai kai noēsai chronos aneu tou nun*).

P2 The now is a 'middle' (*mesotēs*), it has a beginning and end at the same time, "for it is the beginning of the future time and the end of the past" (*archē tou esomenou chronou*) and *teleutē tou parelthontos [chronos]*).

P3 Because it has both a beginning and an end, there must be time on both sides of the now.

C1 So time has not come to be.

P4 If there is time, there must also be motion, "if indeed time is a kind of property of motion" (*ho chronos pathos ti knēseos*).

C2 So motion has not come to be.

The argument from (**P1**-**P3**) to (**C1**) assumes that if time has to come to be, it has come to be at an instant in the sense of a 'now' in the sense of (**P2**).[3] (**P1**) is the crucial premise: it is perhaps an instance of the more general claim that whatever 'happens' to time 'happens' in time. I find even the more general claim rather plausible: time, among other things, is a temporal expanse and its topological and metrical properties are properties of that expanse, i.e. give it an inner structure. This inner structure, by the nature of time, is itself temporal and can only *be* temporal: there is no way for time to have properties that are not also ascribable to its parts and so are temporal.

(**P4**) is not just a statement of ontological dependence: the conceptual connection between time and motion is closer than metaphysically necessary covariation of existence. The idea that time has come into being does not make sense, according to Aristotle, because it would have to happen at some one time. But not only cannot it be at a time (for then there would be a time before that), it also cannot *happen* at all. The becoming-to-be of time, like any other becoming-to-be, would be a motion and so have an intrinsic temporal structure – but this is impossible, if it is time itself that comes to be, for time just is this: the intrinsic temporal structure of comings-to-be. If such structure cannot come to be, it must have always existed, and so there always were things it was the structure of.[4]

At 251b28-252a5, Aristotle says that the 'same argument' as the first shows that motion does not cease to exist: if some motion ceases to exist, only the actuality does, not the movable of which it is the motion; if this movable also ceases to exist, then this is a motion later than the first one, presupposing another movable the actuality of which is the second motion, the ceasing to exist will be a third, subsequent motion etc. I frankly do not find this argument convincing at all. It is one thing to say that if the mover ceases to move that which is moved, then this requires a earlier motion, e.g. a loss of contact. But why think that this earlier motion also has to be later, that it has to go on

3. Though my reconstruction makes it depend on that assumption, I still find it more plausible as the one ascribed to Aristotle by Graham (1999: 47), which depends on two premises I find problematic: (i) that "[t]he existence of the now is a necessary condition for the existence of time", which ascribes to Aristotle a two-way dependence relation between the now and time, of "mutual entailment" (1999: 48); and (ii) that we inductively infer that what is true of the now is true for any arbitrary moment of time.

4. One may think that (**P4**) clashes with the priority of change over time: if time is posterior to change, we cannot also make change posterior to time by inferring properties of the former from properties of the latter. Such a circularity objection, however, is much too quick: Aristotle has a rich repertoire of different notions of priority and can easily distinguish the two relations: he could say, e.g., that while time *measures* change, but change *realises* time.

until after the first motion has ceased to be? Why could not the actuality go out of existence at the same time as the potentiality? Why must the potentiality linger on even after the actuality has ceased to exist?

Fortunately, there is no need for a parallel to the first argument (from the definition of motion) if the second argument (from the eternity of time) works: for the second one is perfectly symmetric with respect to past and future and equally plausibly shows that motion cannot have a beginning and that it cannot have an end.

The third argument is perhaps meant to back up (*P4*) of the first argument. It seems to involve something like a causal closure condition (in Aristotle's sense of "cause", i.e. perhaps something more akin to a version of the principle of sufficient reason). Again, it proceeds by an investigation of what it would mean for motion to have a beginning, but now asks whether this would be compatible with the "orderly" course of nature (252a11-12). It would not, answers Aristotle, if time is linear, because the coming into being of motion would divide such a time into parts (the time before there was motion, the time after there was motion) that do not stand in a proportion: there would thus be no possible explanation of why motion came into being at this, rather than any other time.

Aristotle concludes VIII.1 by claiming that motion is eternal.[5]

In VIII.3, Aristotle argues that (i) some things never move, (ii) some always move and (iii) some only sometimes move. He does so by arguing against four alternatives: that nothing ever moves (establishing $\exists a$), that nothing ever is at rest (establishing $(i) \vee (iii)$), that whatever is at rest (or moves) always is at rest (or moves), and that everything which is at rest (or moves) sometimes moves (or is at rest) (establishing $(i) \vee (ii)$)

no motion It is not possible that nothing ever moves, for we may assume that nature is a source of motion, as the contrary claim (that nothing ever moves) "calls into question the whole of experience rather than some part of it and not only in relation to the natural scientist, but in relation to virtually all the sciences and all judgemetns, since they all make use of motion" (253a34-253b1, 1999: 7).[6]

no rest It is not possible that nothing ever is at rest, for "nature is a principle of rest no less than of motion" (253b9, 1999: 7), and there is a threshold principle for all four types of motion. For increase/decrease, there must a turning-point: nothing can grow indefinitely (as the universe is finite), not decrease indefinitely (as there are no points); when increase turns into decrease or decrease into increase, the thing underlying the change is at rest. For alteration, a fixed amount of underlying gradual change gives rise to some discrete change at a higher-level: with respect to these higher-level qualities, the thing is at rest before and after that change. For locomotion, it is merely asserted that at least sometimes, things are (at rest) in their natural place.

no starting/stopping It is not possible that nothing ever comes to rest or comes to move, for there would be no coming-to-be and no ceasing-to-be, "[f]or if something changes into this, it comes to be this or to occupy this, and if it changes from that, it ceases to be that or to occupy that" (254a11-12, 1999: 8). This is an interesting observation:[7] because every qualitative change also brings into being something – at least an accidental unity, white Socrates, or a lesser entity such as the place of the yellow billard ball (which was the place of the red billard ball just seconds ago), it is plausible to assume that every substantial change is underwritten by some qualitative change: this change, to be what brings into being something that did not exist before, has to start and cannot have been going on forever. This establishes (iii).

only starting/stopping That it is not possible that everything starts or stops, is here not shown but merely asserted.[8] The unmoved mover of VIII.5 is always at rest (never starts), the outermost cosmic sphere of VIII.6 is always moving (never stops).

5. It is not clear to what extent Aristotle's arguments apply not only to Anaxagoras' cosmological model where motion begins once and for all after an indefinite period of rest, but also to Empedocles' view that motion and rest forever alternate (cf. Graham 1999: 58–59). Perhaps this is partially addressed in VIII.2, where Aristotle considers an objection from the analogy with animal motion, starting seemingly spontaneously. He rejects the analogy, holding that animals, because they are living things, are always in motion.

6. He backs this up with an additional argument which we discussed already at p. 28.

7. It is *not*, contra Graham (1999: 70-71), an illicit assimilation of coming/ceasing-to-be to "corollaries of motion", nor an attempt to reduce substantial change to another species of change.

8. Even if this fourth scenario were excluded, Aristotle would not yet have established (i) and (ii). From the exclusion of the first two scenarios we only get that there is something that sometimes moves and something that sometimes is at rest. The exclusion of the fourth does not show that *these* things did not start to move nor start to be at rest, but only that there are some things that move (or are at rest) always if they ever move (or are at rest) at all.

Aristotle does not take his argument to be conclusive, but says that we still have to show that not all things fall under (iii), and that some fall under (i) and some under (ii).

8.2.2 Motion is always owed

Having established that there always is motion, i.e. that always, some things are moving, Aristotle asks why they are moving, concluding in VIII.6 that they are moved by something which itself is unmoved, an unmoved mover.

Physics VIII.4 argues that everything that moves is moved by something, distinguishing between incidental / 'accidental' (*kata sumbebēkos*) and intrinsic / 'essential' (*kath'auto*) motion and between motion by nature and motion by force.

Things moved by nature seem to be the easier case: they seem to be moved by themselves, for nature is *their* inner principle of change.

Things moved by force move either incidentially or intrinsically. If they are moved incidentially, then this coincidence is what moves them, and so they are moved by something. The difficult case is intrinsic motion by force: why is due to something? This class is discussed by Aristotle under the heading of elemental motion: to what is the motion of the four elements due? Aristotle says that while they move by nature, they do not, strictly speaking, move themselves. While it is true that everything that moves by itself also moves by nature, the converse is more difficult to establish: while the elements move by nature, they do not seem to initiate their own movement. Moving 'by nature' thus cannot just mean, as it does in the case of animals and natural things more generally, having an inner principle of change *whereby* one is moved. In the case of the elements it means having a potentiality that is actualised in a way that makes its manifestation spontaneous in the absence of blockers.

Aristotle illustrates this with the help of the first/second actuality distinction and the example of knowledge. Actualising one's potential to know dogs, by learning about dogs, brings us into a state where our knowledge about dogs is spontaneously applied whenever the conditions are right (e.g. whenever we see a dog): no further trigger is needed, though of course the manifestation of our knowledge may be impeded (e.g. by sleep). Movement by force of the elements is such an impediment, and their natural motion is a second actuality, a manifestation of an already activated potentiality:

ἐπεὶ δὲ τὸ δυνάμει πλεοναχῶς λέγεται, τοῦτ' αἴτιον τοῦ μὴ φανερὸν εἶναι ὑπὸ τίνος τὰ τοιαῦτα κινεῖται, οἷον τὸ πῦρ ἄνω καὶ ἡ γῆ κάτω. ἔστι δὲ δυνάμει ἄλλως ὁ μανθάνων ἐπιστήμων καὶ ὁ ἔχων ἤδη καὶ μὴ ἐνεργῶν. ἀεὶ δ', ὅταν ἅμα τὸ ποιητικὸν καὶ τὸ παθητικὸν ὦσιν, γίγνεται ἐνεργείᾳ τὸ δυνατόν, οἷον τὸ μανθάνον ἐκ δυνάμει ὄντος ἕτερον γίγνεται δυνάμει (ὁ γὰρ ἔχων ἐπιστήμην μὴ θεωρῶν δὲ δυνάμει ἐστὶν ἐπιστήμων πως, ἀλλ' οὐχ ὡς καὶ πρὶν μαθεῖν), ὅταν δ' οὕτως ἔχῃ, ἐάν τι μὴ κωλύῃ, ἐνεργεῖ καὶ θεωρεῖ, ἢ ἔσται ἐν τῇ ἀντιφάσει καὶ ἐν ἀγνοίᾳ. (255b)

But the fact that the term 'potentially' is used in more than one way is the reason why it is not evident whence such motions as the upward motion of fire and the downward motion of earth are derived. One who is learning a science knows potentially in a different way from one who while already possessing the knowledge is not actually exercising it. Wherever something capable of acting and something capable of being acted on are together, what is potential becomes actual: e.g. the learner becomes from one potential something another potential something (for one who possesses knowledge of a science but is not actually exercising it knows the science potentially in a sense, though not in the same sense as before he learnt it). And when he is in this condition, if something does not prevent him, he actively exercises his knowledge: otherwise he would be in the contradictory state of not knowing. (Aristotle 2014: 936)

It is because 'potentially' is said in many ways that it is not apparent by what such things are moved – e.g. fire up and earth down. There are different senses in which the learner and one who already has knowledge but is not exercising it are potentially knowers. Every time the active and the passive powers come together, the potential always becomes actual; e.g. the learner moves from being potentially one thing to being potentially another thing (for the person who possesses knowledge but is not using it is potentially a knower in a way, but not in the way he was potentially a knower before he learned). And whatever he is in this latter condition, if nothing prevents him, he actualizes and uses his knowledge – otherwise he would be in the contradictory condition of ignorance. (Aristotle 1999: 11)

When the cold changes into the hot, it automatically and spontaneously burns – no further change is necessary. It will not burn if it is impeded, but this is a mere defeater condition: the lack of impediment is not an enabling condition for the burning, it is not part of its causal history.

But why do they move the way they do, i.e. what are their natural motions? Aristotle's answer to this question is instructingly laconic:

καίτοι τοῦτο ζητεῖται, διὰ τί ποτε κινεῖται εἰς τὸν αὑτῶν τόπον τὰ κοῦφα καὶ τὰ βαρέα. αἴτιον δ' ὅτι πέφυκέν ποι, καὶ τοῦτ' ἔστιν τὸ κούφῳ καὶ βαρεῖ εἶναι, τὸ μὲν τῷ ἄνω τὸ δὲ τῷ κάτω διωρισμένον. δυνάμει δ' ἐστὶν κοῦφον καὶ βαρὺ πολλαχῶς, ὥσπερ εἴρηται· ὅταν τε γὰρ ᾖ ὕδωρ, δυνάμει γέ πώς ἐστι κοῦφον, καὶ ὅταν ἀήρ, ἔστιν ὡς ἔτι δυνάμει (ἐνδέχεται γὰρ ἐμποδιζόμενον μὴ ἄνω εἶναι)· ἀλλ' ἐὰν ἀφαιρεθῇ τὸ ἐμποδίζον, ἐνεργεῖ καὶ ἀεὶ ἀνωτέρω γίγνεται. (255b13-21)

But, be it noted, this is the question we are trying to answer – how can we account for the motion of light things and heavy things to their proper places? The reason for it is that they have a natural tendency towards a certain position; and this is what it is to be light or heavy, the former being determined by an upward, the latter by a downward, tendency. As we have said, a thing may be potentially light or heavy in more ways than one. Thus not only when a thing is water is it in a sense potentially light, but when it has become air it may be still potentially light; for it may be that through some hindrance it does not occupy an upper position, whereas, if what hinders it is removed, it realizes its activity and continues to rise higher. (Aristotle 2014: 937)

This brings us to the crucial question: just why do the light and the heavy move to their own place? The explanation is that it is their nature to go somewhere, and this is what it is to be light or heavy, the one being defined by *up* and the other by *down*. Things are *potentially* light and heavy in many ways, as we have stated. For when something is water, it is potentially light in a way, and when it is air, it is still potentially light, for something may impede it from being up. But if the impediment is removed, it becomes active and goes ever upward. (Aristotle 1999: 11)

The contraries of 'light' and 'heavy' define a dimensional magnitude that is itself 'spatial': to be light just *is* to have a natural upwards tendency: what is light is what goes upwards and what goes upwards is what is light. When water actualises its potentiality to become light / air, it retains its potentiality: it realises it further by an upward movement, and does so spontaneously, i.e. unless it is impeded. The distinction between the first and the second actualisation of water's potential to go up (by becoming air) thus both explains why water cannot go up (but only air does) and why, when it has become air, it does not need a further cause to go up.

This account of elemental motion concludes the argument that everything that moves is moved by something. Things that move by force are moved incidentially, hence moved by something. Things that move by nature either move by themselves (cause themselves to move, as animals do) or (as the elements do) they move in virtue of having a source of motion by being acted on: they are moved by their very essence, by retaining their potentiality to move as a potentiality even when it is actualised by elemental transformation.

8.2.3 Elemental motion and the transmutation of elements

My account of Aristotle's reasoning in VIII.4 that the elements move by nature, not by themselves but still by something (i.e.: their nature) has been harshly criticised by many authors. Graham (1999: 85) says about a similar proposal by Lang (1984):

> The element surely actualizes itself, but Aristotle never says here or elsewhere that the elements are *moved by*, much less *primarily moved by*, their actuality. To say this would, I believe, be a category mistake: an essential cause cannot satisfy the phrase 'moved by –'. […] …'The air was moved by its lightness' would be ill-formed in Aristotelian logical grammar (though the sentence 'The air moved up *because* it was light' would be both well-formed and true.)

The worry about logical grammar is quickly dismissed: there is no reason that natures must be expressed by words like "lightness", "humanity" or "equininity". The error is deeper, however: Aristotle does *not* (try to say) that air moves by its lightness, but that it moves by its nature. Natural things generally are movable by their natures, insofar as having a nature is having an inner principle of change. The elements are special in that they are not just movable, but actually moved by their natures: their nature is to have a certain tendency of motion, and that tendency is always actualised, though not always fully so (as it can be impeded).

That Graham accepts the because-statement and even thinks that it "give[s] a self-sufficient explanation [and] make[s] the explanation the equivalent of an irreducible law of nature in modern physics" (1999: 85) is also quite puzzling: if the because-statement is true and irreducible, then it gives the aition of the motion, and the aition in question can only be the formal cause, which in the case of elemental movement is also the final cause.

"The air moved up because it was light", if not of the form "*p* because *p*" and true at all, is – as a whole, and not just on its right-hand side – a statement about what air is: "air", "light" and "moving up" are just descriptions of the very same element. This explains why the moving of some air is caused, according to Aristotle, by whatever caused the existence of the air in question: that by which the air came to be is the thing that moves it, because for it to be is for it to move a certain way (namely up).

MOVEMENT OF THE ELEMENTS VII.4 and VIII.4 WHERE IS THIS FROM? Aristotle denies that elements are self-movers, and holds that their local motion has an external efficient cause (i.e. the active power that moves them is always external), while they themselves possess merely a passive principle of change (Phys. vii.4, 255a6–18; 256a1–2). Stavrianeas (2015: 57–58) , following Bodnár 1997 and Gill 2009: even though elemental motion needs a per se efficient cause that is external to it, it requires no external stimulus to become active and is thus a capacity to be changed in itself qua itself, and hence natural. AGAINST Matthen 2001, Scharle 2008, Katayama 2011

8.3 The unmoved mover

8.3.1 The regress of movers

Physics VIII.5 argues that there is a first mover and that it is unmoved, by way of a number of regress arguments, showing the relative priority of types of movings,

- distinguishing between direct and indirect transmission of motion, arguing that there must be some direct transmission;
-

The first regress argument reduces indirect to direct transmission of motion. Motion is transmitted indirectly from *a* to *b* if *a* moves *b* by moving something else, *c*; *c* may move *b* also indirectly, by moving *d*, etc. In this progression, we have a relation of priority: while *a* could be moving *b* in some other way, *c* would not be moving *b* if it were not the thing by which *a* moves *b*.[9] It is also a regressive progression: *b* may be said to be moved by *d* (the thing by which it is moved by *c*), and by *c* (the thing by which it is moved by *a*), but ultimately it must also be moved by a first member in the series, *a*. If there were no first member, it would not be moved by any of the intermediate members, for all they do is to transmit the motion they received from the original source of the movement.

In cases where motion is transmitted indirectly, the transmitting elements must themselves be moved, and indirect transmission must ultimately reduce to direct transmission: something moving something by itself. Aristotle presents a second version of this argument, focussing on the attribution of the moving: to attribute *b*'s movement to *a* (and not just to *d* and *c*), we have to reach back from *b*, via *d* and *c*, to *a*. If the series of intermediate causes were infinite, we would not be able to do this and never reach *a*, i.e. never be able to attribute the movement of *b* to *a*.

Aristotle adds a second argument: transmitted motion is contingent, so if every motion were transmitted, every motion were contingent, so it would be possible that there is no motion, which it is not:

εἰ γὰρ ὑπὸ κινουμένου κινεῖται τὸ κινούμενον πᾶν, ἤτοι τοῦτο ὑπάρχει τοῖς πράγμασιν κατὰ συμβεβηκός, ὥστε κινεῖν μὲν κινούμενον, οὐ μέντοι διὰ τὸ κινεῖσθαι αὐτό, ἢ οὔ, ἀλλὰ καθ' αὑτό. πρῶτον μὲν οὖν εἰ κατὰ συμβεβηκός, οὐκ ἀνάγκη κινεῖσθαι τὸ κινοῦν. εἰ δὲ τοῦτο, δῆλον ὡς ἐνδέχεταί ποτε μηδὲν κινεῖσθαι τῶν ὄντων· οὐ γὰρ ἀναγκαῖον τὸ συμβεβηκός, ἀλλ' ἐνδεχόμενον μὴ εἶναι. ἐὰν οὖν θῶμεν τὸ δυνατὸν εἶναι, οὐδὲν ἀδύνατον συμβήσεται, ψεῦδος δ' ἴσως. ἀλλὰ τὸ κίνησιν μὴ εἶναι ἀδύνατον· δέδεικται γὰρ πρότερον ὅτι ἀνάγκη κίνησιν ἀεὶ εἶναι. (256b4-13)

If everything that is in motion is moved by something that is in motion, either this is an accidental attribute of the things (so that each of them moves something while being itself in motion, but not because it is itself in motion) or it belongs to them in their own right. If, then, it is an accidental attribute, it is not necessary that that which causes motion should be in motion; and if this is so it is clear that there may be a time when nothing that exists is in motion, since the accidental is not necessary but contingent. Now if we assume something possible, nothing impossible will follow (though something false may). But the non-existence of motion is an impossibility; for we have shown above that there must always be motion. (Aristotle 2014: 940)

9. I interpret 256a10-11 thus as being concerned with essential dependencies between movings, rather than some general ontological dependence in the way Graham (1999) does.

If everything that is moved, is moved by a moved, either this attribute belongs to things incidentally, so that what is moved causes motion – not, however, because it itself is moved – or it does not belong to them incidentally but intrinsically. In the first case, if the mover is moved incidentally, it was not necessary for it to be moved. But if so, clearly it is possible that at some time no entity is in motion. For the incidental attribute is not necessary but contingent. Thus, if we assume what is possible, nothing impossible will result, although a falsehood may. But for there to be no motion is impossible. For it has been proved earlier that motion is impossible. (Aristotle 1999: 13)

The argument may be laid out as follows:

A Suppose every thing that is moved is moved by something else that is moved.
P1 Being moved by something else that is moved (= *F*) is a property had either incidentially (*kata sumbebēkos*) or intrinsically (*kath'auto*).
P2 If *F* is had incidentally, it is had contingently (not necessarily: *ouk anagkē*).
P3 If *F* is always had contingently, it is possible that it could not be had at all.
P4 If it is possible that *F* is not had at all, it is possible that there is no motion.
P5 It is not possible that there is no motion.
C Hence our supposition is false: there is a thing that is moved but not moved by something else that is moved, but rather either moved by something self-moved or by something unmoved.

Aristotle's explication of (**P2**) is very interesting. If an attribute (e.g. *F*) belongs to some thing incidentally, he says, "what is moved causes motion – not, however, because it itself is moved" (256b6-7). Some thing, *a*, would thus have *F* by coincidence iff (i) *a* is moved by *b*, (ii) *b* is moved but it is not the case that (i) because (ii), but (i) has some other explanation: (i) because of some fact involving some other thing. But in this case there is no link between (ii) and (i) and they could, at least in principle, fail to co-obtain: (i) could be the case even if it were not the case that (ii), in which case we had no assurance that *F* is had by *a*.

The crucial premise, of course, is (**P3**), the step from distributive contingency (for any *x*, it is possible that it is *G*) to collective contingency (it is possible that for all *x*, *Gx*). This is clearly not a logical step,[10], so it is in need of an argument which Aristotle unfortunately does not provide.

In addition, (**P4**) is quite questionable: if nothing is such that it is moved by something else that is moved, then either (i) nothing moves or (ii) everything that moves is either unmoved or moved by something that is not moved. Why should, under the possibility operator, (ii) collapse under (i), i.e. why should we be able to conclude from the possibility of (either (i) or (ii)) the possibility of (ii)?

The third argument is introduced by a tripartite distinction between the mover, the moved and the means: the mover moves, but is perhaps not moved; the means transmits motion, moves and is moved; the moved is moved, but does perhaps not move. With respect to this distinction, Aristotle claims that the transmission of motion must originate in something that is – at least under a certain aspect – not itself in motion:

τὸ δὲ κινοῦν οὕτως ὥστ' εἶναι μὴ ᾧ κινεῖ, ἀκίνητον. ἐπεὶ δ' ὁρῶμεν τὸ ἔσχατον, ὃ κινεῖσθαι μὲν δύναται, κινήσεως δ' ἀρχὴν οὐκ ἔχει, καὶ ὃ κινεῖται μέν, οὐχ ὑπ' ἄλλου δὲ ἀλλ' ὑφ' αὑτοῦ, εὔλογον, ἵνα μὴ ἀναγκαῖον εἴπωμεν, καὶ τὸ τρίτον εἶναι ὃ κινεῖ ἀκίνητον ὄν. (256b20-24)

…and the mover – that is to say, that which causes motion in such a manner that it is not merely the instrument of motion – must be unmoved. Now we see the last things, which have the capacity of being in motion, but do not contain a motive principle, and also things which are in motion but are moved by themselves and not by anything else: it is reasonable, therefore, not to say necessary, to suppose the existence of the third term also, that which causes motion but is itself unmoved. (Aristotle 2014: 941)

But the mover, in so far as it is not the means, is unmoved. When we observe the last moved, which is able to be moved but does not have its own source of motion, and what is moved, not by another but by itself, it is reasonable, not to say necessary, to suppose that there is a third thing which causes motion while being unmoved. (Aristotle 1999: 14)

This is a quasi-conceptual argument: distinguishing, as we can, among the things at least partly responsible for some motion between those that are themselves moving and those that are not, we characterise those of the first class as 'means' or 'instruments', vehicles through which the motion is imparted. It then appears very plausible

10. Though perhaps Aristotle regards it as such.

to suppose that not everything responsible for the motion can be of this kind, i.e. that the second class cannot be empty: something must originate and not just transmit the motion.

As in the previous regress, we start with something which is moved and moving by itself, not accidentally. We then look at the chain of its moving movers (its F-chain, in the terminology from before) and conclude (because there cannot be an infinite F-regress) that it has a last member. This last member, because it is a member of the chain, has a mover, but because it is the last member, this mover does not belong to the chain, i.e. is not itself moved.

Perhaps unsure of the soundness of the first three, Aristotle produces yet two other arguments to show that there is a first (i.e. unmoved or self-moving) mover. The first one addresses the regress of movers directly, arguing that, because there is only a finite number of types of motion and because moving is transitive, every agent of a motion of type F will itself be a patient of a motion of the same type F, which is said to be impossible. But it clearly is not: far from being "absurd" (*alogon*) and "impossible" (*adunaton*), it is quite often actually the case that the teacher is learning (I hope it is the case in our very own situation). This is why Aristotle says that "one must carry to the individual cases", i.e. consider the regress not with respect to teaching but with respect to, e.g., teaching-that-p, not with respect to throwing but with respect to, e.g., throwing in a certain manner. If we do this, however, I see no reason to grant Aristotle the assumption that (even by his own lights) the number of *these infima species* of motion is finite.[11]

The fifth argument considers a regress not of movers, but of movables. "The movable" / "*to kinēton*" in English as in Greek is ambiguous between "what can move" and "what can be moved". The fifth argument, however, does not really concern the existence of a first mover. Taken as such an argument, it simply asserts and does not argue that if we individuate the ways of being movable finely enough, it will be absurd that whatever is potentially an agent of a certain type of motion, necessarily is also potentially a patient of it.

The ambiguity is much more relevant for the next step in the overall-argument, which, "making another beginning", is to ask in what sense self-moving is possible. The claim with respect to the ambiguity of "movable" is that nothing can be 'it's own' movable in both senses of that word, i.e. be agent and patient of the very same process of moving. The overall conclusion will then be that the first mover is intrinsically such that it moves, that it itself is unmoved and that it does not move its parts.

Aristotle starts by recalling the earlier claim that everything that is moved is continuous, i.e. "is divisible into parts that are at every stage divisible". If something moved is moved by itself, it thus must have parts. In order to show that a thing, as a whole, cannot move all its parts conjunctively, Aristotle gives a better argument for the irreflexivity of the infima species of motion, i.e. that e.g. nothing can teach and learn the same thing by the same process:

ἔτι διώρισται ὅτι κινεῖται τὸ κινητόν· τοῦτο δ' ἐστὶν δυνάμει κινούμενον, οὐκ ἐντελεχείᾳ, τὸ δὲ δυνάμει εἰς ἐντελέχειαν βαδίζει, ἔστιν δ' ἡ κίνησις ἐντελέχεια κινητοῦ ἀτελής. τὸ δὲ κινοῦν ἤδη ἐνεργείᾳ ἔστιν, οἷον θερμαίνει τὸ θερμὸν καὶ ὅλως γεννᾷ τὸ ἔχον τὸ εἶδος. ὥσθ' ἅμα τὸ αὐτὸ κατὰ τὸ αὐτὸ θερμὸν ἔσται καὶ οὐ θερμόν. ὁμοίως δὲ καὶ τῶν ἄλλων ἕκαστον, ὅσων τὸ κινοῦν ἀνάγκη ἔχειν τὸ συνώνυμον. τὸ μὲν ἄρα κινεῖ τὸ δὲ κινεῖται τοῦ αὐτὸ αὑτὸ κινοῦντος. (257b6-14)

Moreover, we have established the fact that it is the movable that is moved; and this moves potentially, not in fulfilment, and the potential is in process to fulfilment, and motion is an incomplete fulfilment of the movable. The mover on the other hand is already in actuality: e.g. it is that which is hot that produces heat, and in general that which produces the form possesses it. Consequently, the same thing in respect of the same thing will be at the same time both hot and not hot. So, too, in every other case where the mover must have the synonymous property. Therefore when a thing moves itself it is one part of it that is the mover and another part that is moved. (Aristotle 2014: 944)

Further, we have explained that the movable is what is in motion; but it is in motion through potentiality, not through actuality, and the potential is in process to realization, and motion is the incomplete realization of the movable. But the mover is already actual – for instance, the hot heats, and in general what has the form produces it in others. So the same thing will be hot and not hot at the same time in the same respect, and likewise with everything else in which the mover must have the same name as the moved. Therefore one part of the self-mover causes motion, and one part is moved. (Aristotle 1999: 15–16)

That this argument is supposed to be conclusive is shown by the invocation of the law of non-self-contradiction. The contradiction is supposed to arise from the supposition that the very same thing moves itself, is a movable in both senses of potentially being moved by itself and actually moving itself. Motion, it is recalled, is the actualisation

11. Indeed, there will necessarily be an infinity of them, at least if velocities are counted among the 'manners of locomotion'.

of the potentiality *as a potentiality*, so it is *as movable* that the movable is moved; to be the efficient cause of such moving, it must also be moving *as actually movable*. In the first, passive sense of "movable" (being potentially moved), the actualisation must not yet have been completed (for otherwise the thing would not be being moved, but rather having been moved); in the second, active sense of "movable" (potentially moving something), the actualisation (of the power to move) must have been completed (for without actualisation of the its power to move, the thing would not be moving anything). The very same potentiality, therefore, must and cannot be completely actualised, which is a contradiction.

Having established that nothing can move itself in its entirety, Aristotle excludes the other case where the self-moving thing would not have an unmoved part: something could be self-moving in the sense of having two parts, *a* and *b*, such that *a* moves *b* and *b* moves *a*.

8.3.2 Material for a cosmological argument?

Barry Miller (1982, cf. also his 1992: 96–113, where the argument is included under the heading "Why existence? The *ultimate* answer"). Miller allows that a series of causes can stretch back indefinitely, but he thinks that one particular kind of series needs to terminate: a series where the cause is "unfolded" into further causes on which it depends. So it may be true that *a* is caused by *b*, and that *a* is caused by (*b* insofar as *b* is caused by *c*), and that a is caused by (*b* insofar as *b* is caused by (*c* insofar as *c* is caused by *d*)), and so on. Such a series, Miller argues, has to terminate, because we would otherwise have what he calls an "open sentence".

8.3.3 The primary motion: eternal, of place, continous, in a circle

Physics VIII.6 argues that the first mover is eternal, on the grounds that some of the moving it does is eternal.

Physics VIII.7 spells out different ways in which locomotion, change of place, is the primary motion. Growth and decrease (change in size) cannot be primary, because it by itself only accounts for the element of constancy in change; the variation element must be accounted for in terms of qualitative change, i.e. alteration. This alteration is brought about by a change in something else, an intensification or weakening of some external influence. Ultimately, such intensification or weakening must be due to a change in relative distance, the mover moving closer to or away from what it moves. Aristotle then distinguishes three notions of priority:

τὸ γὰρ πρῶτον, ὥσπερ ἐφ' ἑτέρων, οὕτω καὶ ἐπὶ κινήσεως ἂν λέγοιτο πλεοναχῶς. λέγεται δὲ πρότερον οὗ τε μὴ ὄντος οὐκ ἔσται τἆλλα, ἐκεῖνο δὲ ἄνευ τῶν ἄλλων, καὶ τὸ τῷ χρόνῳ, καὶ τὸ κατ' οὐσίαν. (260b17-19)	As in the case of other things so too in the case of motion the word 'primary' may be used in several ways. A thing is said to be prior to other things when, if it does not exist, the others will not exist, whereas it can exist without the others; and there is also priority in time and priority in being. (Aristotle 2014: 954)	For the primary in the case of motion as well as of other things is said in many ways. For that is said to be prior without which other things will not exist, while it can exist without them, and there is also priority in time and priority in essence. (Aristotle 1999: 22)

In all three senses, locomotion is primary:

existence Locomotion is primary with respect to existence, for (i) growth/decrease and alteration presuppose (the existence of) locomotion and (ii) there would be locomotion even if there were no growth/decrease nor alteration, for there must be continuous motion and only locomotion can be continuous.

time Locomotion is primary with respect to time becaues eternal things cannot grow nor decrease and cannot alter.

essence Locomotion is primary with respect to essence because growth/decrease and alteration of natural things is *for* their locomotion, i.e. locomotion is the telos of the changes of the other two types.

Physics VIII.8 argues that primary locomotion is in a circle, on the grounds that only circular motion is continuous.

VIII.9 further characterises the eternal circular motion as uniform.:

Physics VIII.10 finally argues that the first mover must be simple, on the grounds that because its power must be infinite (causing motion that goes on eternally, i.e. for an infinite amount of time), it cannot have any magnitude (either finite nor infinite).

Chapter 9

On the relevance of the *Physics*

9.1 Aristotelian power structuralism?

9.1.1 Marmodoro on Aristotelian physics

In her also otherwise quite excellent defense of the Aristotelian view that perception is uptake of form without matter, Marmodoro (2014) gives a brief, and very readable overview of Aristotle's physics and metaphysics. I find it interesting because it connects an interpretation of Aristotle's view to contemporary strands in metaphysics, and for this reason propose it as an interpretive foil, to be 'tested' as we go along.[1]

In her ch. 1, Marmodoro (2014) presents the hylomorphic account of change in terms of an underlying matter changing its form between opposites. She attributes to Aristotle two main views of contemporary relevance (2014: 3):

- that all properties are causal powers (δυνάμεις, potentialities);
- that causation is the activation of such powers (ἐν ἐνεργείᾳ or ἐνεργείᾳ, actuality).

Contrary to many contemporary theorists (who normally think that the disposition does not 'survive' its manifestation), Marmodoro's Aristotle will accepts *activated powers* as such, i.e. things that are both powers and actual:

> …the actuality of a power is to be interpreted as its *state of activation*; its exercis*ing* powerfulness. For Aristotle, a power does not cease to be powerful while activated, nor is its powerfulness reducible to mere potentiality…The powerfulness of a power is either the potentiality to bring about change, or the actuality of bringing about change. (Marmodoro 2014: 4–5)

Marmodoro illustrates the point with the first vs. second actuality distinction from *De Anima* (cf. II.1 412a10-11, 21-27 and II.5 417a22-29, 417b2-16). I potentially know Finnish, because I have the capacity to learn Finnish which I would then actualise by speaking Finnish. Learning Finnish is the first actualisation of the my capacity to know Finnish, speaking it the second. The potentiality to second-actualise my potential knowledge of Finnish (i.e. the capacity to speak) is not only compatible with but presupposes its first-actualisation (my learning Finnish).

In the context of *De Anima*, the distinction (I surmise) is supposed to allow Aristotle to combine two intuitively plausible claims: (i) that the colours we see depend for what they are (and not only: for how we see them) on how we see them, *inter alia* on our (types of) eyes; (ii) even before the first eye evolved, burning lava (e.g.) was red (i.e.: it is not the case that coming into being of the first eye *made* things have the colours they (now) have). It allows him to do this because eyes enter only into the *second* actualisation of the colours, light is responsible for the first one:

1. An initial suspicion with respect to its overall interpretational adequacy arises from the quite startling fact that Marmodoro does not discuss the matter-form contrast *at all*. While I think it is true that it serves the same, or at least a very similar purpose as the potentiality-actuality distinction, I still surmise that *both* have to be taken into account to get the full picture. But we will have to assess this suspicion during what lies ahead.

light makes colours visible (and actualises them, for they are visibilia), but eyes make them seen and thereby realise their 'full' potential.

Marmodoro seems to generalise this account quite widely (though perhaps I've misunderstood). The potentiality of water to break, for example, is first-actualised by its freezing, and second-actualised by its being crushed. When the ice is crushed, it is no longer breakable ("brittle"), but its potentiality to break is retained at the stage of its first actualisation (when it is ice). So this is a case where some power (to break) is actualised (by freezing) and retained as a power (at least at the stage of its first actualisation).[2]

Not only is the actualisation of the power (ie. the change it produces under the right circumstances) compatible with its continued existence as a power, it is also *intrinsic* to the power:

> Being activated is simply exercising the powerfulness that defines what the power is. (Marmodoro 2014: 10)

While the 'powerfulness' of powers has to be distinguished from their activation, it is not in need of a categorical basis: powers do not need to be grounded in something which is not a power – they are "pure", in contemporary parlance.

The activation of a power is a state of it, an "activity" the power is "engaged in" (Marmodoro 2014: 13), either instantaneous (*energeia*, *praxis*) or temporally extended (*kinesis* in the strict sense, process). The latter allow for a distinction between partial and full realisation; only when fully realised does the product 'follow' and its end (*telos*) is realised; however, the process is actualised already before and the change is taking place: the change is the house-building, the actualisation of the potentiality *qua* potentiality (while, presumably, the house would be the actualisation of the potentiality *qua* actuality).

The actualisation of a power depends on contact (*thixei*, *Phys.* 202a5-9) with its correlative power, on which it is existentially dependent (the power to heat is activated when its bearer is in contact with something heatable). Powers are thus relative, but not for this reason relations: the power to heat, e.g., is ontologically dependent on the power to be heated (if the second were not to exist, neither would the first, and vice versa), but this dependence is grounded in some of its monadic properties. The power to heat and the power to be heated can only exist (i.e., for Aristotle: be exemplified) together, but not because they are de-relativisations of a conceptually and ontologically prior '*x* heats *y*' relation, but primitively so. To make it plausible that this applies not just to the activation of powers, but to powers-in-potentiality, Marmodoro refers to Aristotle's views of possibility:

> …if there is nothing that can be so affected, how can there be a power whose nature is to bring about that effect? Aristotle believes in some form of the Principle of Plenitude – namely, that what is possible will happen. If so, then it follows that he believes that the end of each power in potentiality must be realizable. (Marmodoro 2014: 32)

When the activation conditions are fulfilled, the activation follows by natural necessity: *unless something external interferes* and *for the most part*, both the active and the passive powers become activated. When the resulting powers are different from those activated (but also: only then),[3] we have change. When the active and the passive power come together, they become activated. This mutual activation of the powers *is* causation (rather than: has a causal effect):

> The interdependence of the relative powers translates into their mutual *qualitative transition* to exercising their powerfulness, which is what their causal interaction consists in. (Marmodoro 2014: 34)

In this causal interaction, Aristotle says, we have a transmission of a form from the active to the passive power (or rather: from the thing exercising the active power to the thing (possibly itself, but *qua another*) exercising the passive

2. One may be forgiven to wonder whether really it is plausible that water (i.e.: the liquid, here in the glass in front of me) *is* breakable? It has, for sure, the potentiality to *turn into* something (perhaps: something identical to it) that is breakable, namely ice, but does it (the liquid, the contents of the glass in front of me) have the *capacity* to break?

3. This additional claim is made by Marmodoro on p. 2014: 33, though on p. 2014: 39 she calls "change" the "actuality or activation of the passive power".

power). The transmitted form is then the "principle or cause" (*arche* or *aition*) of the motion (*kinesis*) (*Phys.* 202a9-12). Even though causation is symmetric (it is the joint activation of correlative powers), the form is transmitted *from* the one *to* the other, though Marmodoro stresses that this is just a figurative way of talking (though also admitting that we cannot explain *for what* it is a metaphor):

> The transference of the form of the active power to the passive one is not a description of the mechanism of causal efficacy, but only of the type of qualitative change that takes place in the passive power. Aristotle has identifed a ground-level activity that cannot be explained by more primitive ontological tools. (Marmodoro 2014: 37)

While it is, in her view, inexplicable (and only metaphorically expressable), the 'transmission of form' has to be itself a process, which takes time and may be interrupted before it is completed: the change is thus the *gradual* reception of the form by the passive power (i.e.: the activation of a thing's power to receive the form), itself a process.

The so-called 'Actualities of Motion' dilemma in *Physics* III.3 may be understood as questioning the compatibility of symmetric causation with asymmetric (even anti-symmetic) transmission of form. We will come back to this argument when discussing the third book.

9.1.2 Criticism

Non-exhaustibility of powers. Crucial to Marmodoro's conception of Aristotelian powers is her conception of their 'powerfulness': that they become activated and produce change while at the same time remaining powers, i.e. powerful. In other words: for Marmodoro, in contrast to most contemporary friends of dispositions, the activation / manifestation of a power is not an event (*produced* by that power, or by the power and its 'manifestation partners'), but a state of that very power.
The first-vs.-second actualisation contrast does not quite do this, as it allows for a weaker reading according to which the first potentiality is strictly speaking *only* the potentiality to acquire a certain skill (speaking Finnish, for example), which is lost when activated, while it is only loosely describable as the potentiality to activate the skill (which, of course, is retained when the skill is acquired). This may be corroborated by the earth-wood-casket case (*Met.* 1049a18-23) Marmodoro (2014: 66, fn. 14) herself cites: while earth is potentially wood and wood is potentially a casket, earth, strictly speaking, is not a casket.

Intrinsicness of the activation to the power. Though Marmodoro (2014: 67-68, fn. 26) is right to distinguish her view from the even more extreme position of Martin (2008: 51) that not only the activation but the very manifestation of the power is intrinsic to it, that 'directedness' is intrinsic is still a strong and somewhat implausible claim. Powers are not activated all by themselves, but only under certain circumstances (the heater has to be turned on, for instance)[4] – why should we not then attribute this activation not partly to the other factors too?
It is true that Aristotle takes the occasion (I should not say: cause) of the activation (fulfilment, the passage from potentiality to actuality) to be something he calls "contact" and conceives of it as something like (what we would call today) an "enabling" or "triggering condition"; it is equally true that the type of contact needed and the type of possible activation partners may be, perhaps even have to be, mentioned in the definition of the power in question. But it still does not follow that the activation is intrinsic, for things may be defined by extrinsic properties.
Presumably, Marmodoro's reason not to think that powers are extrinsically individuated is that their *telos*, the form they are able to 'transmit', is 'given' (specified? determined?) by their activation partners, the correlative passive powers, to which they stand in a relation of ontological dependence which is not a relation. This is certainly true, but not a sufficient reason. For they also also intimately related to their passive powers in another way: when power p_1 becomes activated together with its passive correlate p_2, the process (or activity) which is the activation of p_1 *is (the very same thing as)* the activation of p_2. Aristotle even says that this "sameness-in-actuality" *grounds* the ontological dependence:

4. The dependency on other factors is precisely what is missing from Marmodoro's example of "the relation of a girl to the woman she becomes [said to be] intrinsic to that person" (2014: 20).

> **Since** the actualities of the sensible object and of the sensitive faculty are one in actuality, while different in their modes of being, actual hearing and actual sounding appear and disappear from existence at one and the same moment, and so actual savor and actual tasting, etc., while as potentialities one of them may exist without the other. (*DA* 426a15-21, cited in Marmodoro (2014: 44), emphasis added)

Purity of powers. While it is certainly an acceptable interpretative hypothesis to take Aristotle's powers to be pure, it is not *mandated* by Aristotle's characterisation of them as originative sources of change in *Met.* 1046a9-11. Indeed, Marmodoro herself allows for cases where a power (such as weight) is exercised without there being any change (neither a process nor an activity), such as with the the floor sustaining my weight (2014: 33).

To me, the 'purity' of powers, their lack of non-dispositional properties, makes the existential dependence between reciprocal powers quite mysterious. The power to heat and the power to be heated, Marmodoro says, are existentially dependent: neither could exist without the other. This existential interdependence applies to powers also in their merely potential state:[5] even for some piece of wood to have the *capacity* to heat, there must be things that can be heated. This is quite startling: why could there not be things that are see-able, in principle, such as rocks, without there being anything that has the capacity to see them (e.g. because no eyes have evolved)? This makes only sense to me if see-able things have another, non-dispositional or categorical property that *makes* them see-able, present already before the evolution of the eye and in virtue of which things become see-able once an eye has evolved.

Marmodoro's invocation of the 'principle of plenitude' does not help: even if everything that is possible will eventually happen (i.e.: what never happens could not have happened) and thus forever unactivated powers are impossible, ontological dependence is usually taken to be synchronic (and if it is a genuine diachronic relation, we have a rather new and startling way in which the past determines the future!).

9.1.3 The application to the philosophy of perception

TO BE DONE

9.2 Relations and their monadic foundations

9.2.1 The 'problem of relations'

Aristotle held that relations are "the least of the things there are"[6]

9.2.2 Correlative powers

9.3 The topic of the *Physics*: *kinesis*

The *Physics* is a "lecture concerning nature" (*physike akroasis*) and what is characteristic of natural things (things that exist by nature) is that they have in themselves a source or principle (*arche*) of *kinesis* (*Phys.* II.1 192b14). It is often remarked that the customary translation as "movement" or "motion" is too narrow and that "*kinesis*" applies to all kinds of changes. Together with its contrary (*stasis*, sometimes translated "rest" or "stability"), it covers any time-occupying physical process (cf. Yavetz 2015: xii).

MORE ON WHETHER kineseis CAN BE THOUGHT OF AS PROCESSES tout court

9.3.1 Actuality / potentiality vs. form / matter

TO BE DONE

5. Marmodoro is clear about this implication of her interpretation of the 'powerfulness' of powers 2014: 68, fn. 32; 32, though she also very misleadingly says: "*Pros ti* properties are monadic properties such that their manifestation or activation depends counterfactually on the activation of their correlatives." (2014: 29) – it is not just their activation, but their very existence which so depends!

6. Cf. *Met.* N 1088a22. Ross translates this as "the relative is least of all things a real thing or substance" (1924: 1719), whereas Julia Annas translates "relatives least of all are entities or real objects" (1976: 118). Aristotle argues against (the fundamentality of) relations partially on the ground that they give rise to Cambridge changes (cf. *Met.* N 1088a30-1099b1).

In some sense, Aristotle holds the startling thesis that there are two ways of something, a, to *be* F: to be F in potentiality or potentially and to be F in actuality or actually. "Actually" and "potentially" are thus ways for something to be F in the way "quickly" and "slowly" are ways for someone to be walking.[7] This is a startling claim because we normally understand "potentially" or "in potentiality" as *enlarging* rather than restricting the field in which "F" may be correctly applied. But perhaps not always: if I characterise someone as a "singing philosopher" or as a "red cat", I am not saying that she is always singing or that the cat is red also when it is is sleeping in the dark cellar, but rather that she has the (developped, practical) ability to sing and that the cat is such as to appear red in normal circumstances.

Socrates, if he is anything at all, is a philosopher. But what is this: to be a philosopher? Is it a determining, 'fully actualised' property like being snub-nosed, a way for things to be, a state they are in? Or is it rather implicitly, 'covertly' dispositional, a matter of, when triggered and in the right circumstances, to be philosophising? And what is the latter thing: to philosophise? To manifest a pre-existing disposition, realise an otherwise dormant potential, or to perform an action (of saying, writing, thinking?) that conforms to certain conditions (topic-wise, quality-wise, manner-wise?)? Is Socrates a philosopher when he is asleep, dead drunk, permanently lobotomised? When did he become a philosopher, and in what way? Is he philosophising only when he thinks or speaks clearly, or only when he says intelligent things about philosophical matters (does he ever?)?

How much philosophising does one have to do to be a philosopher?

Deleuze on virtuality

9.3.2 Absolute and relative fundamentality

I AM NOT SO SURE ABOUT THE FOLLOWING, HAVE TO LOOK UP WHAT Fine (2012) SAYS ABOUT THE RELATIVE / FUNDAMENTAL CONTRAST

It is an important, albeit sometimes not sufficiently recognised fact about many of the crucial concepts of Aristotelian metaphysics that they have both a relative/comparative and an absolute/maximalist form. We thus speak of "the essence of", "the substance of", "the form of" and "the matter of" some things, but also of "essences", "substances", "forms" and "pieces of matter". We may take either of these as prior, and then try to define, or at least characterise, the other in terms of it:

(**rel**) x is an essence/substance/form / x is matter $_{\text{def}} \leftrightarrow \exists y(x$ is the essence/substance/form/matter of $y)$

Alternatively, we may also choose to take the other direction of explanation:

(**abs**) x is the essence/substance/form/matter of $y_{\text{def}} \leftrightarrow R(x,y) \wedge x$ is an essence / a substance / a form / matter to degree $n_1 \wedge y$ is an essence / a substance / a form / matter to degree $n_2 \wedge n_1 < n_2$

While (**rel**) is certainly more natural, it is not without problems. If the relation *being the essence (substance/form/matter) of* is irreflexive (i.e. never relates a thing to itself), then there are essences/substances/forms/pieces of matter only if it bottoms out – i.e. if there are things that have essences but are not essences, have substances but are not substances, have forms but are not forms and have matter but are not themselves matter.

9.3.3 Constructional ontology

As Bostock (1995: 1–2, cited after reprint) has remarked, Aristotle, unlike his predecessors, is not so much concerned just with listing the basic the 'ultimate ingredients of the world', but rather to explain the *generation* (*genesis*) of the world as we know it from more fundamental elements.

7. The relevant contrast here is with characterisations that either entail or are at least compatible with a's not being F, as e.g. "false friend" and "apparent friend".

Chapter 10

Conclusions

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