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**Why Can’t Geometers Cut Themselves on the Acutely Angled Objects of Their Proofs?**

**Aristotle on Shape as an Impure Power**

**ABSTRACT**: For Aristotle, the shape of a physical body is perceptible *per se* (*DA* II.6, 418a8-9). As I read his position, shape is thus not merely a necessary condition for the possession certain capacities or powers; it is itself a power, as a physical body can affect our sense organs simply in virtue of possessing it. But this invites a challenge. If shape is an intrinsically powerful property, and indeed an intrinsically perceptible one, then why are the objects of geometrical reasoning, as such, inert and imperceptible? I here address Aristotle’s answer to that problem, focusing on the version of it that he presents in *De caelo* III.8. I argue that if we grant that Aristotle conceived of the shape of a sensible body as some kind of causal power, then the satisfactory resolution of that challenge pushes us to interpret him as having conceived of it as being, more specifically, an *impure* power—that is, as a property that is not only intrinsically powerful but also, in some way, intrinsically non-powerful as well. This is a notable result not only insofar as it illuminates Aristotle’s conception of shape but also insofar as it contributes to our knowledge of Aristotle’s theory of *dunameis* and his ontology more broadly.

**KEYWORDS**: Aristotle; shape; *dunamis*; pure powers; powerful qualities

Squash balls are prone to roll and, as some of us are all too painfully aware, to make concave impressions in flesh. Artists’ erasers, despite being made from about the same amount of the same material, are not. Since their material is the same, it is tempting to appeal to their respective shapes in explaining these differences in their dispositional properties. Squash balls can roll and make concave impressions, it would seem, at least in part because they are round, while artists’ erasers can do neither because they are not.

Aristotle routinely makes moves of this sort. He writes, for instance, that “if one defines the operation of sawing as being a certain kind of dividing, then this cannot come about unless the saw has teeth of a certain kind” (*Phys*. II.9, 200b5-6).[[1]](#footnote-1) Not only, then, must something have an edge if it is to be capable of dividing, it must have a serrated edge if it is to be capable of dividing in the specific manner of sawing.[[2]](#footnote-2) Lacking such edges, squash balls lack the capacity to saw.[[3]](#footnote-3)

On my view, the relation, for Aristotle, between the shape of a sensible body and at least some of its capacities, or powers(*dunameis*), is ultimately much stronger still. As I read Aristotle, a sensible body’s shape is not merely a necessary condition for its possession of certain capacities; rather, its shape is itself a causal power, or intrinsically powerful property. This is strongly suggested by his claim that shape, like color or heat, is among the properties of a thing that are “perceptible in themselves” (*DA* II.6, 418a8-9), for to say that a given property is perceptible *per se* is, I take it, to say that bodies can affect one or more of our sense organs simply in virtue of possessing it.[[4]](#footnote-4)

My aim in the present paper is not, however, to adduce support for the view that Aristotle takes shape to be an intrinsically powerful property. I will instead assume that view with the intention of defending it from a pressing challenge. For one might wonder, if shape were indeed an intrinsically powerful property, and more specifically an intrinsically perceptible one, then why are the objects of the geometer’s reasoning, as such, inert and imperceptible?

In what follows, I develop an Aristotelian response to that challenge, focusing on the version of it that he presents in *De caelo* III.8. As I argue, if one grants that Aristotle conceives of the shape of a sensible body as a causal power, then the satisfactory resolution of that challenge pushes us to interpret Aristotle as conceiving of it as being, more specifically, an *impure* power—that is, as being not only intrinsically powerful but also, in some way, intrinsically non-powerful as well. This is a notable result not only insofar as it illuminates Aristotle’s conception of shape but also insofar as it contributes to our knowledge of Aristotle’s theory of *dunameis* and his ontology more broadly.

1. ***Aristotle’s argument in* De caelo *III.8, 307a19-24***

I begin by showing that Aristotle was sensitive to the problem in question. The critical passage is *De caelo* III.8, 307a19-24*—*his eleventh argument, on Simplicius’ count,[[5]](#footnote-5) against alternative treatments of the simple bodies and, in particular, corpuscular theories, especially the mathematical physics of Plato’s *Timaeus*. While Aristotle’s argument in the passage does not directly challenge the view that shape is an intrinsically powerful property, his argument generalizes, as I will show in the next section, to call that view into question as well.

At this point in the *De caelo*, Aristotle’s primary goal is to undermine the view that the simple bodies are essentially differentiated by their respective shapes.[[6]](#footnote-6) Aristotle writes:

They [i.e., those who hold that that shape essentially differentiates the simple bodies] must also accept the inference that the mathematical solids produce heat and combustion, since they too possess angles and contain atomic spheres and pyramids, especially if there are, as they allege, atomic magnitudes. Anyhow if these functions belong to some of these things and not to others, they should explain the difference, instead of speaking in quite general terms as they do. (*DC* III.8, 307a19-24)

The basic idea of the passage, as I understand it, is that if fire, for example, is characteristically hot and, further, if its capacity to heat is fully accounted for by fire’s shape (say, its being pyramidal) or an aspect of that shape (say, its having acute edges or vertices),[[7]](#footnote-7) then, since those same properties characterize mathematical bodies, too, the immediate objects of geometrical proofs would also be hot, which is absurd.

Aristotle’s reasoning takes the form of a *reductio*. I reconstruct it as follows:[[8]](#footnote-8)

|  |  |  |
| --- | --- | --- |
| * 1. The specific differentia of fire is its shape
 |  | Premise (for *RAA*) |
| * 1. All the characteristic properties of a simple body are identical to or fully accounted for by (one or more aspects of) its specific differentia
 |  | Premise (implicit) |
| * 1. Fire is characteristically hot (i.e., capable of heating)
 |  | Premise |
| * 1. Thus, the capacity to heat is identical to or fully accounted for by (one or more aspects of) the shape of fire
 |  | From 1-3 (implicit) |
| * 1. There is no difference, with respect to shape, between mathematical bodies and physical bodies
 |  | Premise |
| * 1. Thus, a mathematical body of the same shape as fire is hot
 |  | From 4 & 5 |
| * 1. But mathematical bodies are not hot
 |  | Premise (implicit) |
| * 1. Thus, a mathematical body of the same shape as fire both is and is not hot
 |  | From 6 & 7 (implicit) |

As Aristotle reads the *Timaeus*, Plato conceives of the elemental triangles, the faces of the simple bodies, and the simple bodies themselves as being purely geometrical. If Aristotle is correct in reading the *Timaeus* that way,[[9]](#footnote-9) then apart from fire’s geometrical properties, there would seem to be no available candidates in terms of which Plato could explain its characteristic features. Plato would thus be forced to take any putatively intrinsic but non-geometrical properties of fire to be either spurious or identical with or completely reducible to the geometrical ones—that is, Plato would be forced to accept some version of [2].

The canonical response on Plato’s behalf, which traces back to Proclus but is preserved and perhaps developed by Simplicius,[[10]](#footnote-10) accepts Aristotle’s reasoning but challenges that interpretative premise.[[11]](#footnote-11) On their reading of the *Timaeus*, the elemental triangles have depth, minimal though it may be.[[12]](#footnote-12) Moreover, and more to the point, they do *not* take an elemental triangle’s extension in three dimensions to be purely geometrical. Rather, as Simplicius puts it, the elemental triangles (and anything constructed from them) are instead “natural” bodies, having some sort of material constitution. If their alternative reading is correct,[[13]](#footnote-13) then Plato can deny premise [2], claiming that at least some of fire’s intrinsic, non-geometrical properties are not wholly explicable in terms of its shape and depend either instead or in addition on its matter. This does not yet fully free the Platonist from accepting the paradoxical claim in line [6],[[14]](#footnote-14) but it is a promising initial move in responding to Aristotle’s challenge.

1. ***Aristotle’s argument, generalized***

For Aristotle, of course, no shape is either essentially or necessarily predicated of an elemental body. Indeed, Aristotelian elements are adaptable in shape.[[15]](#footnote-15) Accordingly, on his view, there is no possibility of accounting for an elemental body’s characteristic powers in terms of shape. Aristotle, that is to say, at a minimum rejects [1] and [4]. As such, and as we should expect, his own treatment of the bodily elements is not susceptible to the criticism that he levels against those like Plato’s in *De caelo* III.8.

What matters for my purposes, though, is that Aristotle’s argument generalizes in a manner that calls into question *any* attempt to explain one or more of a thing’s capacities solely in terms of its shape. The lynchpin in Aristotle’s argument is premise [5]: namely, the claim that mathematical bodies and physical bodies do not differ with respect to shape. With that premise in place, if a given capacity (including that to affect our sense organs in some determinate sort of way) were identical with or completely reducible to some particular shape, then it would seem to follow that the capacity be possessed equally by physical and mathematical bodies of that shape, which is absurd. Since my operational assumption is that Aristotle, independently of his treatment of the bodily elements, regards shape as an intrinsically powerful property, this threatens my reading of his own position.

To make the point clear, we might pose a generalized version of Aristotle’s challenge, mirroring lines [4] through [8] of the original, as follows:

|  |  |  |
| --- | --- | --- |
| 1. Some capacity, *φ*, is identical to or fully accounted for by (one or more aspects of) the shape of a physical body possessing it
 |  | Premise (for *RAA*) |
| [5]  | There is no difference, with respect to shape, between mathematical bodies and physical bodies |  | Premise |
| 1. Thus, a mathematical body of the same shape as a physical body possessing *φ* also possesses *φ*
 |  | From 4\* & 5 |
| 1. But mathematical bodies are inert—they have no capacities
 |  | Premise |
| 1. Thus, a mathematical body of the same shape as any physical body that possesses *φ* both does and does not possess *φ*
 |  | From 6\* & 7\* |

The premise in [4\*] is a generic version of the sub-conclusion in [4], above. Whereas [4] was restricted to a particular capacity of a particular simple body and its shape, [4\*] is not. The modified premise is satisfied if *any* capacity of *any* physical body is identical with or fully accounted for by that body’s shape. Provided the remainder of the generalized version of the argument fairly parallels the original, this premise should be the obvious target for elimination.

But rejecting [4\*] would have serious consequences for Aristotle’s views about the relationship between shapes and capacities. In particular, it would preclude Aristotle from treating shape as an intrinsically powerful property of any sort, perceptible or otherwise. This is because if shape were an intrinsically powerful property, then, precisely as [4\*] asserts, at least one capacity would, in fact, be identical to or fully accounted for by the shape of a physical body possessing it.

1. ***Three unsuccessful strategies for responding on Aristotle’s behalf***

Since, on my view, Aristotle does treat shape as an intrinsically powerful property, at least in the sense of being intrinsically perceptible, I will proceed on the assumption that rejecting [4\*] on his behalf is not a viable option. But if Aristotle cannot reject [4\*], then we must find some other manner of freeing him from the hooks of his own argument. In this section, I consider three superficially promising lines of response and explain why each fails. This will spur me, in the next section, to distinguish the various ways in which one might construe shape as an intrinsically powerful property. Those distinctions, as I will show, suggest at least one way for Aristotle to maintain [4\*] but still dodge the generalized argument’s untenable conclusion.

With the exception of the anodyne inference to [8\*], each line is a plausible candidate for attack. I take them up in reverse order, as [7\*] might initially seem to be the weakest point in the argument. It claims not merely that mathematical bodies are inert, but also that the reason for this is that they are incapable of acting. There are grounds for resistance, then, because Aristotle entertains at least one alternative explanation for inaction. On his view, capacities are operative only under certain conditions.[[16]](#footnote-16) A sighted creature, for example, will not see if there is no light. But it is not as if sighted creatures go blind when it gets dark; rather, each preserves its capacity to see but is hindered from exercising it. In analogous fashion, then, Aristotle has the resources to claim that mathematical bodies are intrinsically powerful (say, in being capable of affecting our sense organs) but never have and never will exercise their powers because at least some of the conditions necessary for their manifestation systematically fail to obtain.[[17]](#footnote-17)

Yet, this move, on Aristotle’s behalf, to construe mathematical bodies as intrinsically powerful (in virtue of having the capacities that their shapes afford) but accidentally inert (in virtue of being systematically precluded from exercising those capacities) is not enough to save him. At least, it is not enough to save Aristotle without doing violence to his claims elsewhere in the corpus. Of special relevance is his treatment of abstraction, or removal [*aphairesis*].[[18]](#footnote-18) The objects of geometrical reasoning, Aristotle claims, just are physical bodies but considered as stripped of all their sensible qualities. He writes, for example:

the mathematician investigates abstractions, for in his investigation he eliminates all the sensible qualities … and leaves only the quantitative and continuous, sometimes in one, sometimes in two, sometimes in three dimensions, and the attributes of things *qua* quantitative and continuous, and does not consider them in any other respect. (*Meta*. K.3, 1061a28-35)

In considering sensible things only insofar as they are quantitative and continuous, Aristotle is clear, we consider them independent of *any* capacities. We might, on this point, note his contention that even after removing the “affections, products, *and capacities* of bodies,” quantities still remain (*Meta*. Z.3, 1029a13). Accordingly, Aristotle is not poised to resist [7\*] by claiming that mathematical bodies are intrinsically powerful but accidentally inert.

So what about [6\*]? Since it very closely mirrors [6], which was the central, explicitly drawn inference of Aristotle’s original challenge, this is perhaps the most secure move in the generalized argument. Any Aristotelian attack on its validity raises the complaint that he argued in bad faith against the Timaean position. Still, it merits our consideration. There is, so far as I see, at least one reason to call it into question. One might accept that a given shape, or aspect thereof, *is* identical to some capacity, *φ*, but nonetheless maintain that nothing mathematical *has* that capacity[[19]](#footnote-19)—for instance, because mathematical matter is not a genuine predicative subject.[[20]](#footnote-20) On this view, one could be entitled, from [4\*] and [5], to claims of the type that a mathematical sphere *is* identical to some capacity but not to claims of type that that it *has*, or *possesses*, that capacity.

The trouble with this response to [6\*] is two-fold. First, it runs afoul of the same features of Aristotle’s treatment of removal as the response that we considered to [7\*]. If in proceeding from a physical sphere to a mathematical sphere by removal one intellectually strips the former of all its capacities, then there will not be any capacities left over for the mathematical sphere to be identical to. Second, the claim that a mathematical body is identical to some capacity is, if anything, moreabsurd than the claim that mathematical bodies have that capacity. Suppose, for example, that a mathematical sphere were identical to the capacity to roll along inclined planes.[[21]](#footnote-21) Would it not follow, then, that when Archimedes proved that the surface area of the mathematical sphere is 4πr2 he also proved that the surface area of capacity to roll along inclined planes is 4πr2? Surely there is a category mistake at work in any such purported theorem and the attending characterization of mathematical practice.

Is [5] the culprit, then? Since it was retained, verbatim, from the original argument, there is no more room to complain of problems here than with respect to his original challenge. Yet, perhaps Aristotle’s use of the premise is merely dialectical. A prominent interpretation of Aristotelian mathematical objects suggests precisely that. It is unlikely that the shape of any physical sphere will satisfy the rigid definitional constraints on mathematical ones. Accordingly, such interpreters argue, if the geometer’s claims are true, then when she reasons about spheres, the objects of her reasoning must differ in shape from physical spheres; and so, granting the truth of mathematics, there *is* a difference, with respect to shape, between mathematical spheres and physical ones.[[22]](#footnote-22)

Yet, whatever the fate of [5]—as I will argue, Aristotle can and should resist it—this sort of response to it is ultimately moot. Even supposing that the shape of no physical sphere is identical to that of a regular mathematical one, every physical sphere still has *some* shape, however irregular, available for mathematical study. Since nothing in the argument requires us to read [5] as claiming that the shape of a given physical body is the same as that of a *particular* mathematical one, this response cannot get Aristotle very far.

1. ***Shape as an impure power and Aristotle’s resolution of the argument***

I have been assuming that Aristotle takes shape to be an intrinsically powerful property. But such properties are subject to rather diverse analyses.[[23]](#footnote-23) Since there are multiple options available, we ought to more directly consider the solution space. As I will show, while some of the options are of little help to Aristotle in responding to the argument, one class of options provides him with a way to meet it in a manner that is both philosophically and interpretatively appealing.

The basic task, then, is to characterize the possible construals of the strongest intrinsic relation between, for example, a squash ball’s being spherical and one or more of its various capacities, whether to roll along inclined planes, to make concave impressions, to affect our sense organs in some distinctive manner, or the like. Since Aristotle nowhere surveys the relevant options, I look to more recent literature on the metaphysics of powers for guidance. This strategy raises the threat of anachronism. But if the options presented are exhaustive, and if we remain mindful to avoid foisting foreign distinctions onto Aristotle’s remarks, any anachronisms in the resulting presentation of his view should remain appropriately faithful to its substance.

On to the options, then. Positions on which shape is an intrinsically powerful property may be divided into those on which being powerful exhausts its nature and those on which it does not. The first and stronger class of positions treats shapes as *pure* *powers*. Such positions come in two basic forms. In its stronger form, what we might call a simple pure power view, a given shape just is some *one* power. On this form of the view, being spherical, for example, might be no more and no less than being capable of rolling along inclined planes. In its weaker form, what we might call a complex pure power view, a given shape just is some *collection* of powers. On this latter form of the view, being spherical might instead be construed as being no more and no less than being capable of rolling along inclined planes *and* being capable of making concave impressions *and* being capable of affecting our sense organs in some determinate manner.[[24]](#footnote-24)

This first class of positions, whether in its simple or complex form, is unable to capture Aristotle’s view, however. Construing shape as a pure power is in tension, in particular, with his treatment of removal. As we saw, in considering physical bodies solely insofar as they are quantitative and continuous, Aristotle thinks we strip away *all* of their powers. Yet, if being powerful exhausted the nature of a shape, then to take away all the powers of a physical thing would be, among other things, to take away its shape. That is to say, if Aristotle thought shapes were pure powers, then he would have to deny, in the face of considerable textual evidence, that they were properties of bodies *qua* quantitative and continuous. Accordingly, Aristotle should *not* be taken to have construed shapes as pure powers.

But in that case, on the assumption that Aristotle did construe shapes as powers of some kind or other, Aristotle is committed, at least implicitly, both to adopting a distinction between pure and impure (or, non-pure) powers and to treating shapes as being of the latter type.[[25]](#footnote-25) & [[26]](#footnote-26) Let us, then, survey the second generic class of positions, which treats shapes as *impure powers*. An impure power is an intrinsically powerful property, but one whose nature does not exclusively consist in being powerful. That is, an impure power is a property that is not only intrinsically powerful but also, in some way, intrinsically non-powerful as well. Such positions also come in two basic forms. In its stronger form, usually called a “dual-sided” view, shape is a metaphysically complex property, having both powerful and non-powerful components that are distinct in being. The idea is that shapes “have something *about them* that is irreducibly and ineliminably dispositional, and something (else) *about them* that is irreducibly and ineliminably non-dispositional.”[[27]](#footnote-27) In its weaker form, the distinction between the powerful and non-powerful “components” of a shape is instead construed as one merely in thought. On this latter form of the view, a shape is, as a whole, both a power and a non-power.[[28]](#footnote-28)

Taking Aristotle to construe shape as an impure power of either variety is compatible with his treatment of removal. On each form of the view, there is a non-powerful component of some kind or other to any impure power, at least in thought. As a result, even after intellectually stripping away all of the powers of a physical body, something of its shape would still remain to characterize the object arrived at through removal.

More importantly for my purposes, though, taking Aristotle to construe the shapes of physical bodies as impure powers provides fresh resources with which to resolve the generalized version of the argument that he leveled against Plato at *De caelo* III.8, 307a19-24. Premise [5], in particular, is now suspect. Aristotle can maintain that the shapes of mathematical bodies are in one sense the same but in another sense different, for the mathematical body would, as it were, have only an attenuated version of the property belonging to its physical counterpart.[[29]](#footnote-29) That is, mathematical bodies and physical bodies would indeed differ with respect to shape, with the former lacking the powerful dimension of the shape of its physical counterpart. This, in turn, would allow Aristotle to explain why, even though shape is an intrinsically powerful—and indeed, intrinsically perceptible—property, geometers cannot see the proper objects of their proofs, let alone cut themselves on or be heated by them. Namely, in dealing with an abstract object, the geometer has already removed, from the physical body, the component of its shape in virtue of which it is intrinsically perceptible or otherwise powerful. With this response to [5] accepted, Aristotle can thus block the inferences to [6\*] and, in turn, to the untenable conclusion in [8\*], all the while leaving [4\*] intact.

1. ***Conclusion***

I have argued that the challenge that Aristotle levels against his predecessors at *De caelo* III.8, 307a19-24 bears on interpretations of his own positive views. In particular, I have argued that if we grant that Aristotle conceived of the shape of a sensible body as some kind of causal power, then we should take him to have conceived of it more specifically as an *impure* power. Since a prominent recent interpretation instead paints Aristotle’s ontology as one of purepowers only,[[30]](#footnote-30) this represents a notable contribution to our understanding of his theory of *dunameis* and, more generally, his ontology.[[31]](#footnote-31)

Of course, one might still reject my operational assumption that, for Aristotle, shape is an intrinsically powerful property. Indeed, it might seem that if that assumption were granted, then, according to my reconstruction of Aristotle’s solution to the challenge at *De caelo* III.8, “shape” would turn out to be improperly ambiguous. On my reading, Aristotle’s uses of “shape” are admittedly equivocal. But, by way of conclusion, let me say that this is not only unproblematic, it is an interpretive advantage, as it can explain something about Aristotle’s treatments of both shape and body that would otherwise be rather puzzling.

Consider the following. Aristotle’s categories are widely, and I think rightly, presumed to be mutually exclusive. For example, if an item belongs to the category of substance, then it should not also belong to the category of quantity. And yet, Aristotle twice appears to frustrate that expectation. He presents both shape and body as belonging to *two* categories, seemingly vacillating between, on the one hand, presenting shape as a quality and body as a substance and, on the other hand, presenting both shape and body as quantities.[[32]](#footnote-32)

On the above distinction between the shape of a physical body and that of its mathematical counterpart, however, this is perfectly natural. Body, in the category of substance, is *sensible* body. Among the qualities that it has is shape, construed as an impure power. When all the powers of that body are stripped away via removal, only an attenuated version of that shape (just its non-powerful component or aspect), now a mere quantity, remains. This attenuated shape either just is or, alternatively, is possessed by the *mathematical* body, a quantity as well. The interpretation of Aristotle’s conception of shape that I have developed, in addition to any other virtues it may have, thus neatly dissolves a worry about the apparent dual location of shape and body in Aristotle’s categorical scheme.[[33]](#footnote-33)

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1. All translations of Aristotle’s works follow those in Barnes 1984. [↑](#footnote-ref-1)
2. Aristotle’s central point in the broader context of the passage is that saws can only be made of certain types of materials, like iron. But in making that point, which is not directly about a saw’s shape, he nonetheless also makes a claim about the shape of anything capable of sawing since being serrated, or toothed, is here a geometrical property. Teeth “of a certain kind” might seem to implicate a more specific determination of that geometrical property, but we should instead read the qualification as pointing to the non-geometrical properties (e.g., hardness) that constrain the types of materials from which saws can be made. [↑](#footnote-ref-2)
3. Aristotle takes differences in shape to explain not only cases in which one thing lacks a certain capacity that another possesses, but also cases in which two things with the same capacity manifest it differently. For instance, while the shape of a thing does not account for its heaviness or lightness, it can, he thinks, explain why two equally heavy bodies will reliably manifest their common capacity to move downward—that is, fall—more or less quickly (*DC* IV. 6, 313a14-15). [↑](#footnote-ref-3)
4. Whether Aristotle, in claiming that shape is perceptible *per se*, is committed to the view that shape is, in whole or in part, a power to act on the senses will turn on one’s interpretation of his theory of perception more generally. For an especially well-developed treatment of that theory on which “the perceptible qualities of objects are real powers of the object to interact causally with the perceivers,” see Marmodoro (2014, 3). Aristotle is reasonably explicit on the relevant point in the case of the special sensibles. He writes, for example, that “a thing is white, fragrant, noisy, sweet, hot, cold in virtue of a power of acting on sense” (*Meteor.* IV.8, 385a2-4).

In her recent work, Marmodoro (2014, forthcoming a, and forthcoming b) advances an interpretation of Aristotle’s ontology as grounded in causal powers, and causal powers alone. If this is right, and if we can assume, as seems clear, that Aristotle takes shape to be a genuine property of at least some substances, then even independent of any specific claims about his theory of perception, shape must either itself be a causal power or be exhaustively reducible to causal powers. The view that I will present is compatible with Marmodoro’s position that Aristotle’s ontology is grounded in causal powers alone but challenges the way in which she develops it and, in particular, her claim that, for Aristotle, all of those powers are *pure* powers. [↑](#footnote-ref-4)
5. Simplicius’ parsing of the objections has long been widely followed. For a nonstandard construal, at least with respect to the passage in question, see Elders (1966, 326–327). [↑](#footnote-ref-5)
6. That view appears earlier in *De caelo* (see, e.g., III.7, 306a30-31) but becomes Aristotle’s focal concern in III.8, which opens with a statement of Aristotle’s thesis that the view is, quite generally, “absurd [*alogon*]” (306b4). He regularly highlights the view as his target (306b13-15, 306b30-31, 307a18, and 307a35) and ends the chapter with the judgment that “from what has been said it is clear that the difference of the elements does not depend upon their shape” (307b18-19). [↑](#footnote-ref-6)
7. See *Timaeus* 56a7-b1, 56d8-57a2, and especially 61d5-62a5. [↑](#footnote-ref-7)
8. The focal inference is to [6]. Aristotle in fact says that his opponents “must accept” that mathematical bodies, *generally*, are hot. For this stronger claim, he relies on the conclusion of the preceding argument (*DC* III.8, 307a13-19), the tenth objection on Simplicius’ reckoning. Aristotle there argues that if a body’s capacity to heat were identical to or fully accounted for by its having edges or vertices, then all the simple bodies would be hot, to some degree, because each has edges or vertices. Since this earlier argument employed a weak dialectical premise (neither Democritus nor Plato can be plausibly interpreted as thinking that fire is hot on account of its having edges or vertices *merely* of some type or other [*cf*. 307a13-14]), I have restricted [6] to a specific class of mathematical solids—namely, to those of whichever shape one assigns to fire, the characteristically hot simple body. This restriction thus puts Aristotle’s point on firmer dialectical footing and better highlights the independent force of the argument in question. Further, it does so without sacrificing the patent falsity of the claim in question. What is absurd is that *any* mathematical solid should produce heat and combustion, not that all (rather than just a few) do.

How, then, is the inference to [6] secured? Aristotle claims that proponents of [1] must accept it “*since* they [= mathematical solids] too possess angles and contain atomic spheres and pyramids.” The key premise is thus some sort of claim that physical bodies and mathematical ones have certain geometrical properties in common. Aristotle is here open to the possibility of a retort. To advance one, he alleges, proponents of [1] “must state (*leckteon*) the [relevant] difference” between physical bodies and mathematical ones. Yet, Aristotle seems to think, proponents of [1] have so far done nothing, save perhaps some hand waving (“speaking in quite general terms”), to that end. From this, it appears [a] that the central dialectical issue is whether physical bodies and mathematical ones differ in a relevant way, [b] that any relevant difference will pertain directly to their respective geometrical properties (“they *too* possess angles…”), and [c] that the burden falls on proponents of [1] to supply such a difference if they want to dodge the inference to [6]. My [5] makes this explicit.

But [1] and [5] alone do not yet warrant the inference to [6]. To fill out the argument, one first needs to tie the capacity to heat to fire. [3] does this, stipulating that fire is characteristically hot. This is accepted by all parties, as Aristotle highlights in the immediate context: “the very properties, powers, and motions, *to which they paid* *particular attention* in allotting shapes, show the shapes not to be in accord with the bodies. *Because fire is … productive of heat and combustion*, some made it a sphere, others a pyramid” (306b29-33).

Still, for the inference to [6] to even appear valid, Aristotle needs to *exhaustively* tie the capacity to heat to fire’s shape. Fire’s having the capacity to heat “on account of” (*dia*: 307a14) its shape is not enough, as its capacity might then additionally depend upon other features of fire that a mathematical body of the same shape lacks. (This point, we will see, is pertinent to Proclus and Simplicius’ defense of Plato). [4] thus states that fire’s capacity to heat is explicable *completely* in terms of its shape. Yet, [4] cannot function as an independent premise in Aristotle’s complaint since it is neither obviously related to the position in targeted in [1] nor dialectically innocent, like [3]. For that reason, I’ve suggested [2] as a bridge from [1] and [3] to the subconclusion at [4]. Unlike the other premises, though, [2] is speculative—I find little in the context to provide any guidance as to what, precisely, should help secure [4]. My construal of the missing premise has the virtue of highlighting what the Platonists will later challenge in Aristotle’s argument, as I explain below. It is also flexible with respect to what it might take for one property to be accounted for, fully or otherwise, by another. But I am not too concerned to defend my construal of [2] since this premise will play no role in the generalized version of the argument that I will introduce in the next section of the paper. [↑](#footnote-ref-8)
9. There is considerable, though not univocal, evidence supporting Aristotle’s interpretation. A particularly telling point in favor of it comes from Timaeus’ account of the transformations of fire, air, and water. A few simple calculations reveal that the transformations he describes preserve surface area—or, the number of constituent triangles—but not volume. For example, at *Timaeus* 56d6-e2, Timaeus claims that one water corpuscle (composed of 120 elemental triangles) transforms into one fire and two air corpuscles (24 + 48 + 48 = 120 elemental triangles). Yet, if constructed from the very same base triangles, the volume of an icosahedron would be more than twice the combined volume of a tetrahedron and two octahedra. This suggests that no stuff of any consequence is bounded by these geometric figures. [↑](#footnote-ref-9)
10. See especially *in De Caelo* 563,26-564,3 and 665,16-20. [↑](#footnote-ref-10)
11. Thus Simplicius’ admission that “*if* those who say that solids are composed of planes and resolve solids into planes said that the planes are mathematical and have only length and breadth, *then Aristotle is correct* to introduce against them these absurdities and the ones which he adduces next” (*in De Caelo* 563,26-30, trans., Mueller 2009a). [↑](#footnote-ref-11)
12. Falcon (2005, 47) traces interpretations of the elemental triangles as extended in three dimensions at least as far back as Epicurus. [↑](#footnote-ref-12)
13. Opsomer (2012, 156 n.38) finds earlier interpretations of the elemental triangles as being hylomorphic in Iamblichus and the *Timaeus Locrus.* Perhaps the strongest point in favor of this reading is Timaeus’ claim that the elemental triangles deteriorate with age and so occur in different degrees of purity (*Tim*. 81c *ff*). [↑](#footnote-ref-13)
14. Siorvanes (1996, 219) reads Proclus and Simplicius as regarding Aristotle’s second and eleventh challenges as “nothing more than ‘jokes’ and ‘mocking jests.’” But in fact, they take Aristotle’s worries seriously. Simplicius comments, *pace* Siorvanes’ interpretation, that Aristotle’s eleventh challenge, if successful, “reduces *the theory* [namely, of the *Timaeus*] to great absurdity and comedy” (*in DC* 664,25-26, trans., Mueller 2009b, my emphasis).

Whether Proclus’ response is successful is another point of contention. Cherniss (1944, 158) finds it satisfactory, but notes that Aristotle, who complains of the “quite general terms” in which the Academics speak, probably would not. I am on Aristotle’s side here, as it is not clear how—or even, that—the *Timaeus* itself takes fire’s capacity to heat to depend on anything more or other than aspects of fire’s shape. For even if Proclus is right to think that the *Timaeus* offers grounds for rejecting the general claim asserted in [2], it is not clear that it offers grounds for rejecting the more local claim about fire’s capacity to heat asserted in [4], in which case the absurdity has not yet been dispelled. Timaeus admittedly appeals to the “swiftness of [fire’s] motion” in his account of the capacity (*Tim*. 61e3). But as Cleary (1995, 128) notes, fire’s motion was already analyzed, apparently reductively, in terms of its shape at 56a7, where Timaeus claimed that fire, given its shape, was “*of necessity* [*anangkê*] the most mobile” of the simple bodies. For a well-developed attempt to make the *Timaeus*’ Platonist interpreters speak more pointedly on why *none* of the capacities of a simple body are eliminatively reducible to its shape, see Opsomer (2012, 166–168). [↑](#footnote-ref-14)
15. The moist elements—water and air—are, however, *more readily* adaptable than the dry ones—namely, earth and fire. On this point, see especially *GC* II.2, 329b29-31 and *Meteor*. IV.4, 381b29. [↑](#footnote-ref-15)
16. Indeed, Aristotle claims, the full specification of a capacity includes a specification of the conditions of its exercise; see, e.g., *Meta*. Θ.5, 1047b31-1048a2. [↑](#footnote-ref-16)
17. This would allow Aristotle to reject [7\*] while still maintaining that the Timaean position is absurd, since Timaeus, if he’s doing physics rather than mathematics, needs the simple bodies to actually heat other things. [↑](#footnote-ref-17)
18. “Abstraction” has the tendency to misleadingly suggest that one’s mental efforts are directly targeting the property distinctive of the abstract object produced—for example, one mentally operates, in some way, directly on the shape of a mug, or mugs, in producing the abstract conception of that shape. This is not Aristotle’s model. “Removal” is preferable since, on his view, an abstract object is what remains after one has subtracted the *other* properties of a thing. On Aristotle’s terminology, see Cleary 1985.

Removal is not far from Aristotle’s mind when leveling the argument at *De caelo* III.8, 307a19-24. At the beginning of *De caelo* III, he hints that the solution to the puzzles raised against the *Timaeus*’ mathematical physics can be resolved by properly distinguishing between the objects of physics and, via removal, those of mathematics; he claims, “there will be difficulties in physics which are not present in mathematics; for mathematics deals with an abstract and physics with a more concrete object” (*DC* III.1, 299a15-17). Kouremenos (2013, 111) notes the passage in connection with *DC* III.8, 307a19-24 but does not draw out, as I intend to, how, specifically, it might help resolve the puzzle there. [↑](#footnote-ref-18)
19. A related distinction, between being a nature and having a nature, plays a central role in the argument of *Physics* II.1, on which see Scharle 2009. Interestingly, after introducing it, Aristotle’s immediate concern, in II.2, is to distinguish the mathematician from the natural philosopher. [↑](#footnote-ref-19)
20. For an argument against ascribing a doctrine of mathematical matter to Aristotle, see Corkum 2012, sec. 2. [↑](#footnote-ref-20)
21. For the association, see *De caelo* II.8, 290a10 and III.8, 307a7-8. [↑](#footnote-ref-21)
22. Mueller is well-known for developing this line of reasoning, arguing that “mathematicians treat objects which are different from *all* sensible things” in shape (1970, 157, my emphasis). For a notable response, see Lear 1982. [↑](#footnote-ref-22)
23. Intrinsically powerful properties go by many names in contemporary metaphysical discussions, from “capacities” to “powers” to “abilities” to “dispositions.” For an overview, see Choi and Fara 2014. Since Aristotelian *dunameis* often fail to neatly fit those discussions, I try to beg as few questions as possible in setting up the taxonomy in this section.

Of course, one need not follow Aristotle, at least on my reading of his position, in construing shape as an intrinsically powerful property. Indeed, Aristotle is in the minority camp on this point. Views on which shape is *not* intrinsically powerful come in two basic flavors.

On the one hand, one might think that shapes are in no way whatsoever related to capacities. On such a position, the squash ball’s being spherical, for example, is completely orthogonal to any capacities it happens to have. This is a conception of shapes on which they are, we might say, resolutely non-powerful. Historically, views of this type have had few champions. One suspects that it would be attractive principally to someone who denied the existence of powers in general, in which case there would be nothing of the kind for a ball’s shape to be in any way related to. Parmenides, for whom what-is is spherical (DK 28B8.43-45) but changeless (DK 28B8, *passim*) and presumably necessarily so, may have held such a position.

On the other hand, one might think that shape, though intrinsically inert through and through, is accidentally related to one or more powers. This is, I take it, the basic position of Newtonian physics. Matter, in itself, is thoroughly inert and lifeless. Yet, in virtue of the laws of nature, which are metaphysically contingent and independent of whatever happens to materially exist, there are accidental if nomically necessary relations between the shapes of material bodies and their behaviors. On such a view, given the laws of nature, squash balls are indeed capable of rolling along inclined planes, but were the laws of nature different, such bodies might instead be capable of hovering or, say, turning into purple rabbits. Democritus seems to have held a view of this sort only without laws of nature to mediate the connection between shapes and capacities. Atoms are “incapable of affecting or being affected” (DK 68 A57; see also, DK 67 A14, 68 A1, 68 A49, and 68 A60). The void is similarly “powerless and inert” (Simplicius, *in Phys.* 571,29 [not in DK]). But powers—and more specifically, sensible qualities—are not so much purged from his ontology as they are rendered non-fundamental. For example, Democritus associates the capacity to cut through entanglements of atoms (and, in turn, the capacity to heat) with broadly spherical atoms and composites. If we take atomic inertness seriously, though, the association between being broadly spherical and having the capacity to cut or to heat can be neither logically nor metaphysically necessary. (For a compelling argument that, despite his claims to atomic inertness, Democritus is nonetheless philosophically committed to treating the atoms as being intrinsically powerful, see Franklin 1986, 62–63). [↑](#footnote-ref-23)
24. Simple pure powers can mimic the diverse manifestations of complex pure powers if construed as being multi-track and/or multi-stage. A simple, multi-track pure power is a unitary power with diverse manifestation types arising from its interaction with diverse stimuli types. A simple, multi-stage pure power is a unitary power with diverse manifestation types arising from its diverse stages of activation. For discussion, see Marmodoro (2014, sec. 3.1).

With respect to shape, however, one reason to prefer a complex view over any version its simple cousin is that shapes would seem to be far more finely individuated than powers. To make the point concrete, consider that despite the fact that all the forks in my utensil drawer came from the same mass-produced set, the shape of each one differs, even if only minutely, from that of every other. As such, a simple pure powers view would be committed to taking the shape of each fork as being a distinct unitary power. A complex pure powers view, by contrast, could acknowledge that the forks have subtle differences in their respective powers but account for those differences with a relatively small set of more basic powers in diverse combinations. [↑](#footnote-ref-24)
25. This dual commitment, it bears noting, is independent of any need to respond to the *reductio* in section 2; it stems directly from his treatment of removal and the claim that shape is an intrinsically powerful property. [↑](#footnote-ref-25)
26. Impure powers are more commonly called “powerful qualities” in the literature. My label stresses that the distinction between them and pure powers exhausts the class of intrinsically powerful properties. [↑](#footnote-ref-26)
27. Molnar 2003, 149, original emphasis. Molnar does not himself endorse the position, whether with respect to shapes or properties more generally. It is associated in the contemporary literature chiefly with C. B. Martin. [↑](#footnote-ref-27)
28. I include under this umbrella both categorical-dispositional identity theories, like that of Heil 2003, chap. 11, and neutral monist theories, like that of Mumford 1998. Such views are weaker than their dual-sided cousins in the following sense: if, as dual-sided views assert, the powerful and non-powerful components of a shape are distinct in being, then they are presumably also distinguishable in thought. [↑](#footnote-ref-28)
29. Or, if there is no mathematical matter, the mathematical body would simply *be* an attenuated version of the property belonging to its physical counterpart. [↑](#footnote-ref-29)
30. Marmodoro 2014, forthcoming a, and forthcoming b. [↑](#footnote-ref-30)
31. Despite my attention to causal powers, my argument has comparatively limited implications for how we should read Aristotle’s broader doctrine of the four causes, on which the contributions in Viano, Natali, and Zingano 2013 make an excellent starting point. [↑](#footnote-ref-31)
32. For the view that body is a substance, see, e.g., *Categories* 5, 2b1-3; for the view that it is a quantity, see, e.g., *Categories* 6, 4b24. For the view that shape is a quality, see, e.g., *Categories* 8, 10a11-16; for the view that it is a quantity, see, e.g., *De Anima* III.1, 425a17-18.

Studtmann, noting that Aristotle often takes body to be a substance, claims that Aristotle’s treatment of it as a quantity “is thus not merely puzzling but seems to commit Aristotle to a contradiction” (2013). Studtmann’s resolution of the tension makes a related appeal to removal, though on his reading (for which, see Studtmann 2002), quantitative bodies instead differ from their substantial counterparts specifically in not being mobile. Compare also Bernier 1999. [↑](#footnote-ref-32)
33. The germ of this paper was first presented in a talk at the 36th Annual Richard B. Baker Philosophy Colloquium at the University of Dayton. I delivered the draft that sprouted from it at the 2015 Northwest Ancient Philosophy Workshop. I am indebted to participants at both events for discussion and owe special thanks to Rosemary Twomey, who prepared formal comments for the latter meeting. I am also deeply grateful to Anna Cremaldi, Myrna Gabbe, José Lourenço, and anonymous referees for written comments on subsequent drafts. [↑](#footnote-ref-33)