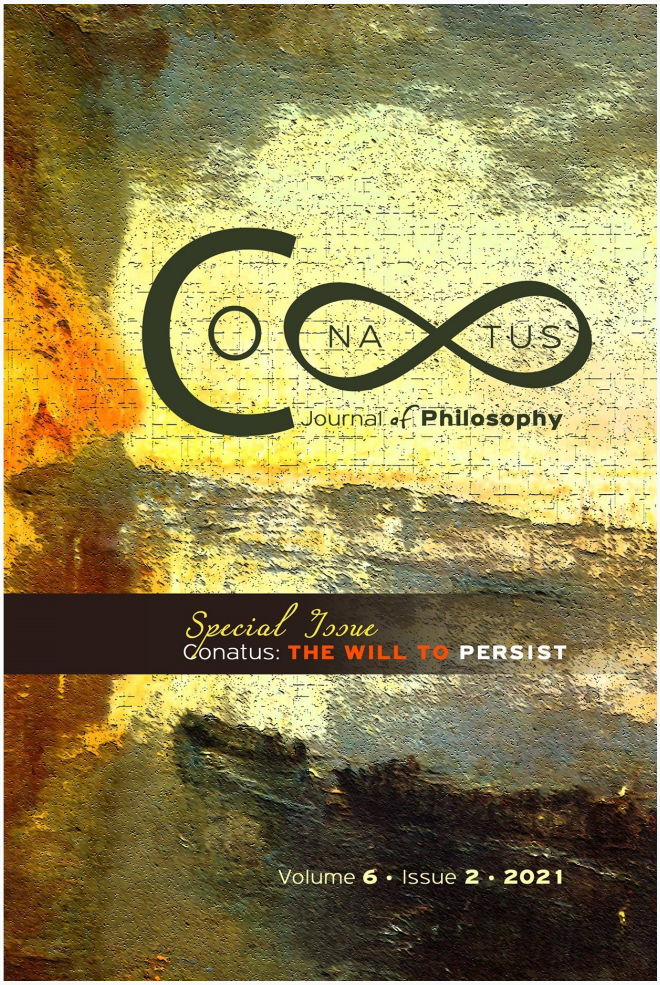
**Conatus - Journal of Philosophy**

Vol 6, No 2 (2021)

Conatus - Journal of Philosophy SI: Conatus - The Will to Persist




# Nature's Perfection: Aristotle and Descartes on Motion and Purpose

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doi: 10.12681/cjp.25684

J. Humphreys · *Conatus* 6, no. 2 (2021): 87-106
DOI: https://doi.org/10.12681/cjp.25684

# Nature's Perfection: Aristotle and Descartes on Motion and Purpose

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**Abstract**

*Descartes holds that, insofar as nature is a purposeless, unthinking, extended substance, there could be no final causes in physics. Descartes' derivation of his three laws of motion from the perfections of God thus underwrites a rejection of Aristotle's conception of natural self-motion and teleology. Aristotle derived his conception of the purposeful action of sublunar creatures from his notion that superlunar bodies are perfect, eternal, living beings, via the thesis that circular motion is more complete or perfect than rectilinear motion. Descartes' reduction of circular motion to rectilinear motion, achieved through his theological foundation of the laws of motion, thus marks a crucial break from Aristotle's philosophy of nature. This paper argues that the shift from the Aristotelian conception of nature as self-moving and teleological to the Cartesian conception of nature as purposeless and inert, is not an empirical discovery but is rooted in differing conceptions of where perfection lies in nature.*

**Keywords:** *Aristotle; Descartes; motion; physics; conatus; teleology; mechanism*

## I. Cartesian conatus

You swing a ball in a sling in a circle above your head. When you let go, the ball flies off. Why does it travel in a straight line, rather than continuing on its circular path? Descartes argues in *The Principles of Philosophy* that when the ball is in the sling, it has *conatus*, a tendency or striving to follow a straight path, which is arrested and constrained into a

circle by the sling. The circular motion of the ball is a compound of rectilinear motion and a contravening, resting force.[1]

While he likely adopted the term "conatus" from scholastic sources, Descartes' argument is directed against Aristotle's doctrine that circular and rectilinear motion are different in kind.[2] For Aristotle, this rather arcane distinction underwrites a conception of the cosmos on which its sublunar and superlunar regions are systematically divided by the kinds of motions that occur within them. Aristotle's division is motivated by metaphysical considerations about the relation of indestructible superlunar bodies to mortal, sublunar creatures. He holds that the purposeful self-motions of sublunar creatures are imitations of the perfect motions of superlunar substances. Descartes undermines this teleology by attacking the metaphysical assumptions underlying Aristotle's account of motion. But Descartes can establish his alternative only on the basis of a theological doctrine that derives the principles of motion from the perfections of God. Moreover, his rejection of Aristotelian teleology depends on attributions of conatus, a seemingly purposeful endeavor or striving, to inanimate objects.

The plan for the paper is as follows. Section II. develops the distinction between circular and rectilinear motion in *De caelo* I.2, a text that sets up Aristotle's division between superlunar and sublunar motion. Section III. argues that this distinction between the two kinds of motion is crucial to understanding Aristotle's conception of teleology, since sublunar creatures are purposeful insofar as they imitate but do not directly participate in the perfect, circular motion of the heavens. Section IV. returns to Descartes, arguing that his account of the laws of motion in the *Principles of Philosophy* depends on a conception of perfection that is related to – but distinct from – that of Aristotle. If the argument of the paper is correct, Descartes' disenchantment of nature depends primarily not on the formulation of a new scientific method, but on a distinctively modern and monotheistic conception of the perfection of nature.

## II. Moving in Aristotelian circles

Aristotle's *De caelo* begins with a characterization of natural science as knowledge of bodies and magnitudes, with their properties and motions,

[1] Today we could characterize this as centripetal force, which leads the ball to feel an acceleration. This acceleration changes the direction (but not the magnitude) of the ball's velocity. However, in this paper I refrain from using post-Newtonian language, which threatens to obscure and pre-judge my central philosophical themes.

[2] See Rodolfo Garau, "Late-Scholastic and Cartesian Conatus," *Intellectual History Review* 24, no. 4 (2014): 479-494.

and with the principles that belong to those substances.[3] Accordingly, the first chapter discusses body and magnitude, features of the whole of nature. Change (κίνησις) never arises in this context, since it is only qua parts that physical objects change relatively to one another. Yet in the second chapter, Aristotle puts aside the topic of whether "nature of the all" is infinite or limited, claiming that this can be addressed only when one has an account of the parts in hand. Here change becomes thematic, since a thing's nature (φύσις) is its principle (ἀρχὴ) of change, and every natural body and magnitude can move locally (κατὰ τόπον) in virtue of itself (καθ' αὑτά). Such intrinsic locomotion – which I call "motion" throughout this discussion – must be either circular, rectilinear, or a combination of the two.[4]

What justifies the inference from a body's being natural to its possessing an intrinsic principle of motion? Aristotle here assumes a distinction made in *Physics* II.1 between natural objects – including animals and their parts, plants, and simple bodies, earth, fire, air, and water – and artifacts like cloaks and beds. The former but not the latter "have an innate impulse to alteration" (ὁρμὴν ἔχει μεταβολῆς ἔμφυτον).[5] This is the only instance of the word, ὁρμή, in the *Physics*, so the significance of the construction is not immediately evident.[6] In the *Nicomachean Ethics*, Aristotle employs the term to refer to an irrational impulse in the psyche or a rousing of irrational desires, which is opposed by reason and good laws.[7]

> Hurrying on toward danger on account of being driven (ὁρμᾶν) by pain and temper, while foreseeing none of its terrors, is not courage; for then even donkeys would be courageous when they are hungry, since being beaten will not hold them back from their food.[8]

Courage depends on not being ruled by one's impulse, but rather by acting deliberately, in full consciousness of the danger one faces. Aristotle attributes ὁρμή to beasts as well as to humans, arguing that humans alone can exhibit

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[3] Aristotelis, *De caelo libri quattuor*, ed. D. J. Allan (Oxford: Oxford University Press, 2005), 268a1.

[4] *De caelo*, 268b15.

[5] Aristotelis, *Physica*, ed. W. D. Ross (Oxford: Oxford University Press, 1950), 192b13-20.

[6] Aristotle does use ὁρμή in other physical works, where he typically associates it with Democritus. See e.g., Aristotle's description of surface tension at *De caelo*, 313b1-8.

[7] Aristotelis, *Ethica Nicomachea*, ed. I. Bywater (Oxford: Oxford University Press, 1894), 1102b21, 1116b30, 1180a23.

[8] *Ethica Nicomachea*, 1116b33-1117a1. I have modified the translation of Joseph Sachs, *Aristotle's Nicomachean Ethics* (Newbury, MA: Focus Philosophical Library, 2002).

courage, since only they can resist their irrational impulses by obeying law and reason. In the *Physics*, ὁρμή is evidently used in a broader sense, since it is supposed to govern the movements not only of ensouled creatures, but also of simple bodies. Yet in both physical and ethical works, the term signals the innateness of the motion it causes. A simple body's tendency to motion is not accidental, just as it is no accident that the donkey pursues food. Moreover, while ὁρμή can be overpowered by force when one is moved in an "unnatural" way, it is in some sense ineliminable.[9]

Aristotle's appeal to intrinsic locomotion in *De caelo* I.2 is based on the presupposition that natural bodies possess a sort of internal striving that is explanatory of their actual motions. From this presupposition, the chapter proceeds by distinguishing species of simple motion:

| Circular | Rectilinear |
|---|---|
| [I] About the center | [II] Away from the center |
| | [III] Towards the center |

Aristotelian species of simple motion

Aristotle defines motions with respect to an unmoving center, deriving complex motions from them by mixture of [I], [II], and [III]. A body is simple just in case it contains a principle of natural motion. A body compounded from simple bodies will have a motion compounded of the simple motion of each of its constituent bodies. In such a complex body, one of the simple motions will predominate, presumably when one of the simple bodies, such as fire, predominates in the compound.[10]

Aristotle's target in this section is not to analyze simple bodies as such, but to develop the distinction between superlunar and sublunar motion on which his cosmology depends.[11] His central argument is a complex conditional:

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[9] Aristotle must distinguish between the self-motion of living creatures, and the innate locomotion of inanimate bodies, a task he sets for himself in *Physics* VIII. 4. For a discussion of this text, in relation to Aristotle's account of elemental motion in *De caelo*, see Mary Louise Gill, "The Theory of the Elements in *De caelo* 2 and 4," in *New Perspectives on Aristotle's* De caelo, edited by A. C. Bowen, and C. Wildberg, 139-162 (Leiden: Brill, 2009).

[10] *De caelo,* 269a1.

[11] Aristotle's discussion of simple bodies in this section is clearly carried out at a higher level of abstraction than it is in his other works. In *On Generation and Corruption*, 330b31-331a6, b2-10, Aristotle identifies fire and air as forms of body moving away from the center, while earth and water are forms of body moving towards the center and discusses their transformations into one another. In *De caelo*, however, he is interested in giving a quite general account of the basic species of motion.

If [1] There is a simple motion, and
[2] Circular motion is simple, and
[3] Simple motion is of a simple body (for [a composite] body moves with simple motion if it is moved according to a prevailing [simple body]), then
[C] Necessarily there is some simple body that moves in a circle according to its own nature.[12]

Aristotle's aim is to show, from the incapacity of the four simple bodies – fire, air, water, and earth – to move in a circle by nature, that there must exist a "fifth element," aether, that moves in a circle by nature. The existence of the aether, over and above the four simple bodies, underwrites his distinction between the sublunar and superlunar motions.

Aristotle's argument here is apparently a bad one: [2] seems to imply [1], since we make sense of [2] only by supplying an existential quantifier, that is, by taking it to mean: "There is a x, such that x is a simple, circular motion." A separate statement establishing the existence of such motion, as in [1], appears to be unnecessary. Moreover, in dividing [I] from [II] and [III], Aristotle postulates that circular and rectilinear motion are both species of simple motion. Thus, it seems that, even if we accept [1] as stated, and take [2] to indicate that circular motion is a species of simple motion, this is insufficient for establishing that there is *in fact* any simple, circular motion, as required for [C]. It could be the case that only the rectilinear species of simple motion are actualized. Moreover, all that is entailed by [3] is that some simple body has some simple motion, not that there is a simple body that necessarily has *circular* motion. The premises thus seem to be neither necessary nor sufficient for establishing that any simple body in fact has circular motion.

Unless one wants to attribute an invalid argument to Aristotle, these premises must be given a different interpretation.[13] Taking "simple motion" to mean motion of types [I], [II], or [III], I suggest that we re-write the first two premises as implicitly having the form:

[1'] A (species of) simple motion is necessarily realized; and
[2'] Circular motion is a (species of) simple motion.

From these premises, it follows that

[4'] circular motion is necessarily realized.

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[12] *De caelo,* 269a2-7.

[13] I follow Sydney Shoemaker, *Physical Realization* (Oxford: Oxford University Press, 2007), 10, in using "realize" and its cognates to mean "make real" in a constitutive rather than a causal sense.

Following this "realization" reading of the first two premises, one can reinterpret the third premise as meaning that:

> [3'] For any simple motion, there is a simple body that realizes that motion.

Reading the third premise as the claim that simple bodies must realize simple motions produces a valid argument: [C] follows from [3'] and [4'] by modus ponens.[14]

In the remainder of the chapter, Aristotle argues that the four simple bodies could not be the realizers of simple circular motion. Each of these simple bodies has a natural (κατά φύσιν) motion and a contrary unnatural (παρά φύσιν) motion, so that fire and air naturally move up, and thus realize [II], while water and earth move down, realizing [III]. But since these motions are contrary to one another, none of the listed simple bodies has an opposite that can realize [I]. Consequently, because [C] has been established, there must be some fifth simple body, aether, that realizes natural circular motion.

Though these arguments are interesting in their own right, I wish to emphasize that Aristotle thinks of circular motion, and thus of the fifth element that realizes it, as being naturally prior to the rectilinear motion of the four elements. Thus, in the course of eliminating the four elements as candidate realizers of circular motion, he writes,

> But circular motion must be primary. For that which is complete is prior in nature to the incomplete, and the circle is among complete things, whereas no straight line can be so. Neither can an infinite straight line be so, for to be complete it would have to have an end or limit, nor a finite line, for all finite lines have something beyond them: any one of them is capable of being extended.[15]

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[14] Aside from saving Aristotle's argument, the "realization" reading helps make sense of his parenthetical comment that "a composite body moves with simple motion if it is moved according to a prevailing" simple body. This is meant to disarm the objection that a simple motion need not be realized by a simple body, since it may be realized by a complex body. Aristotle's reply is that because a complex body inherits the movement of its most pervasive constituent, any complex body with motion of type [I], [II], or [III] must contain a simple body with the respective type of motion. Thus, if a complex body realizes a simple motion, it does so in virtue of containing the simple body that intrinsically realizes that simple motion. For example, a complex body composed of fire, water, and earth could realize [II] in virtue of containing fire, since of its constituents, fire, is the simple body that realizes [II].

[15] *De caelo*, 269a19-23.

Circular motion is naturally prior to rectilinear motion because it is more "perfect" or "complete" than rectilinear motion, just as the circle is a more complete figure than a straight line. An infinite straight line is imperfect in the sense that it is unlimited, a finite straight line in that it is always extendible. Both lack the inherent concept of limitation possessed by the circle. Though Aristotle does not here say what he means by natural priority, in the *Metaphysics* he suggests that what is posterior cannot be without that which is prior.[16] If that is the meaning intended here, then all rectilinear motions are ontologically dependent on the complete, circular motions of the heavens.

Other statements in the chapter corroborate this interpretation. After arguing for the existence of the fifth simple body, Aristotle claims, "From this, it is clear that there exists some bodily substance besides the four in our sublunar world, which is more divine than, and prior to, all these."[17] This suggests that what is more complete and simpler is more divine. Moreover, since we observe fire naturally moving upward, away from the center, heavenly bodies cannot be composed of fire. Aristotle concludes that there must be "some other body separate from those around us, having a more honorable nature as much as it is removed from" the sublunar world.[18] Aristotle's division of circular from rectilinear motion thus corresponds to the division between the sublunar and superlunar heavens. Sublunar things are "lower" than superlunar things in the spatial sense of being closer to the center, but also in an axiological sense of being less complete and divine.[19] Natural motion in the sublunar world is incomplete and finite, so its realizers must come to a halt. Such a halting occurs when the predominant constituent in a sublunar body comes to its natural resting place: fire on air, air on water, water on earth, and earth, presumably, on earth, down to the center.

Aristotle's separation of circular from rectilinear motion depends on an axiological understanding of natural completeness or perfection. Moreover, his separation of the eternal superlunar sphere from the sublunar sphere

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[16] Aristotle, *Metaphysics,* 1019a1-4.

[17] *De caelo*, 269a30-32.

[18] Ibid., 269b13-17.

[19] For discussion of whether cosmic circular motion can be reconciled with Aristotle's doctrine of the prime mover in *Physics* VIII and his theological doctrine in *Metaphysics* V, see Emanuela Bianchi, *The Feminine Symptom: Aleatory Matter in the Aristotelian Cosmos* (New York: Fordham University Press, 2014), 145-147; Helen Lang, *The Order of Nature in Aristotle's Physics* (Cambridge: Cambridge University Press, 1998), 173-186; Aryeh Kosman, "Aristotle's Prime Mover," in *Self-Motion: From Aristotle to Newton*, eds. Mary Louise Gill, and James G. Lennox, 135-154 (Princeton, NJ: Princeton University Press, 1994). Though discussion of the complex interpretive issues involved in this debate is beyond the scope of the present paper, I observe that Aristotle must exclude the divinity from his natural philosophy, on the pain of violating his own distinction between the three parts of theoretical philosophy: physics, mathematics, and theology.

in which every individual is limited and mortal stems from this distinction between kinds of motion.

## III. Aristotle's cosmic teleology

How does Aristotle's doctrine of motion relate to his teleological view of nature, to which Descartes so strenuously objected?[20] According to Aristotle, creatures naturally act for the sake of a final end; for example, teeth continue growing throughout an animal's life for the sake of chewing. A standard interpretation takes these final causes to be irreducible potentials possessed by a natural creature, which may be different from the final causes of its material constituents.[21]

A debate has arisen about the epistemic status of Aristotelian final causes.[22] Gotthelf thinks observation is necessary and sufficient for establishing teleological claims. Waterlow holds that observation is not sufficient for establishing them. However, I argue that the sublunar teleology assumed by Aristotle is a consequence of the different species of motion he believes to be at work in the superlunar and sublunar spheres. If this is correct, sublunar teleology is assumed within Aristotle's system as a rule of inference

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[20] Aristotle's teleology refers to his view that there are natural final causes, which are "that for the sake of which" things act as they do (Aristotle, *On the Generation of Animals*, 715a4f). According to Aristotle, knowledge that x acted for the sake of y counts as causal, since when one says the end y for the sake which x acts, one has explained *why* x acts in that specific way (*Physics* 194b33-195a2). Canonically, one invokes final causes to answer a 'why'-question when one gives the function: for example, Aristotle holds that teeth, but not other bones, continue to grow throughout life *because* they tend to get worn down over time as an animal chews food (*Generation of Animals* II, 745a19-745b9). Here, the answer to the question, 'why do teeth continue growing as an animal ages?' is answered when one says what it is for the sake of which they grow.

[21] Allan Gotthelf, "Aristotle's Conception of Final Causality," in *Philosophical Issues in Aristotle's Biology*, eds. A. Gotthelf, and J. G. Lennox, 204-242 (Cambridge: Cambridge University Press, 1987), 227-228, defends this view against two alternatives. On the 'immaterial agency' interpretation, natural teleology is understood in analogy to human action, so that final causes are understood to involve a conscious or quasi-conscious guidance of the process they govern. On the 'explanatory condition' interpretation, final causes are not *real* causes, but merely play a specific role in explanations of natural processes. Gotthelf's view is supposed to avoid both the extreme of attributing conscious agency to natural processes, and of denying that final causes are real causes.

[22] Gotthelf holds that this irreducibility is not an a priori premise of Aristotle's natural philosophy, but is itself an empirical conclusion drawn from the observation of nature. Sarah Waterlow, *Nature, Change, and Agency in Aristotle's Physics: A Philosophical Study* (Oxford: Oxford University Press, 1982), 91, argues that while the irreducibility thesis is unobjectionable, Gotthelf's image of an 'empiric Aristotle' is overstated. Gotthelf and Waterlow agree, then, that Aristotle is committed to the irreducibility of final causes and that he sometimes appeals to observation to ground claims about elemental motion. Indeed, we saw in the last section that Aristotle appeals to the observation that fire travels upward as an objection to the view that superlunar bodies are composed of fire.

in making causal deductions. In other words, Aristotle's belief in final causes is not an empirical claim at all, but a wholly a priori thesis that derives from his conception of perfection.

Aristotle outlines the causal dependence sublunar motion on superlunar causes in the *Meteorology*. While fire, earth, and other elements are the "causes" of what happens in the sublunar sphere in the sense that they form the underlying material of all sublunar creatures, their cause in the sense of the principle of motion is a δύναμις of eternally moving bodies.[23] While δύναμις typically means "capacity" or "potential," here his thought is that the movement of sublunar elements is generated by the "power" possessed by superlunar bodies that are eternally in motion. A little later in the same text, Aristotle suggests a mechanism by which superlunar bodies can exercise influence on sublunar bodies: in the upper region as far as the moon, aether is contaminated by admixture of air and fire, and exercises power on these sublunar elements. When this low-hanging aether becomes corrupted,

> the circular motion of the first element and of the bodies it contains dissolves, and inflames by its motion, whatever part of the lower world is nearest to it, and so generates heat.[24]

These passages suggest that sublunar elemental motion derives from the interaction of fire and air with aether in the area around the moon. If aether is the realizer of perfect motion, then rectilinear motion is caused by its corruption. The eternal motion of the heavens is the power that produces motion among sublunar creatures by generating heat in the air and fire beneath the moon.[25]

One might object that this theory could only provide an account of the efficient cause of some sublunar elemental motions, but not of the purposeful motion of every sublunar creature. After all, if the final cause of a sublunar creature is an irreducible potential, then Aristotle's explanation of elemental motion in the *Meteorology* is far from explaining the distinctive motions of

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[23] Aristotle, *Meteorology*, 339a30-33

[24] Ibid., 340b10-14.

[25] An anonymous reviewer points out that the Aristotelian account of the corruption of aether implies that higher elevations will tend to be hotter than lower ones. This is an empirical prediction, which the Cartesian could falsify by observation, e.g., of snow on mountain tops. Could the choice between Aristotelianism and Cartesianism then be made on empirical grounds? For two reasons, I doubt that it could be. First, many of Aristotle's false predictions about specific phenomena could be saved by the addition of ad hoc hypotheses. Second, Descartes himself seems far less concerned with refuting particular Aristotelian doctrines than with replacing Aristotle's concepts of body and motion with his own. This suggests that, while Aristotelian and Cartesian physics can be interpreted as rival scientific theories *post hoc*, from Descartes' point of view, they were two ontologies of nature that stemmed from distinct notions of perfection.

compound creatures, such as plants and animals. Nevertheless, I think that Aristotle again appeals to eternal motion to explain the motion of living creatures, implying that their natures, as innate impulses to change, derive from superlunar, eternal motion.

Because sublunar living things cannot preserve themselves "in number" as individuals, each individual has a natural drive to preserve itself "in kind" as species.[26] Consequently, in *De anima,* Aristotle claims that every sublunar living thing has nutritive psyche, by which it strives to perpetuate itself through reproduction.

> For the functions of [the nutritive psyche] are reproduction and the use of food; for it is the most natural function in living things, such as are complete and not mutilated or do not have spontaneous generation, to produce another thing like themselves – an animal to produce an animal, a plant a plant – in order that they may partake of the everlasting and divine in so far as they can; for all desire that, and it is for the sake of that which they do whatever they do in accordance with nature. Yet that for the sake of which is twofold – the purpose for which and the beneficiary for whom. Since, then, they cannot share in the everlasting and divine by continuous existence, because no perishable thing can persist as numerically one and the same, they share in them in so far as each can, some more and some less; and what persists is not the thing itself but something like itself, not one in number but one in species.[27]

For Aristotle, sublunar animals naturally desire to preserve themselves, for the sake of participation in the eternal and divine. Unlike superlunar bodies, however, the corruptible material of the animal ensures that it is individually perishable, that it cannot persist as a "one." Consequently, animal and plant reproduction acts as a sublunar surrogate for the eternal activity of superlunar things. The basic functions of life down here are an imperfect image of the eternal life of the divine bodies in the heavens.[28]

Aristotle views the fundamental functions of sublunar life – nutrition and reproduction – as value-laden and goal-directed activities that imitate

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[26] Aristotle makes this distinction at *De generatione et corruptione*, 338a19-b17, noting that coming to be and passing away are "rectilinear" changes that could not affect superlunar bodies.

[27] Aristotle, *De anima* 415a25-b7. The translation modifies that of David W. Hamlyn, *Aristotle De anima Books II and III*.

[28] Plato's *Phaedo* (78d) and *Symposium* (208a-b) are literary antecedents of this passage.

the activities of eternal substances. The same axiological vision underlies Aristotle's explanation of the activities of superlunar bodies, which he also understands to be ensouled, living creatures. Thus, the activities of sublunar animals can be understood in reference to their goals: "To attain the ultimate end would be in the truest sense best for all; but if that is impossible, a thing gets better as much as it is nearer to the best."[29] Consequently, objects near the earth have few motions, and "do not arrive at the ultimate thing, but reach only as far as they happen to be able to the divine principle."[30] In distinction, the first heaven reaches its goal "by one movement."[31] Thus, Aristotle assumes an axiological order of self-motion, beginning with the perfect rotation of the first heaven, and descending downward, to other heavenly bodies that achieve their goal through many motions, and finally to the creatures moving on the surface of the earth, who participate in the divine only by imitation. At each level, Aristotle considers the bodies to be self-movers, that is, living animals pursuing specific goals. Nevertheless, attributions of purpose to sublunar creatures are ultimately justified by reference to the activities of eternal superlunar creatures.

One might think that since Aristotle's attributions of sublunar teleology (for example, that animals have feet in order to walk) depend on his superlunar teleology, his view must be overtly theological, so that the purposes of individuals can be explained by the purposes of god. Indeed, Aristotle's use of the epithets of divinity to describe superlunar bodies and their motions seems to support this view. Nevertheless, it would be a mistake to conclude that Aristotle's cosmology rests on an appeal to theology. For his assertion of the divinity and perfection of the superlunar bodies, and hence his explanation of sublunar teleology, does not depend on any conception of a cosmic designer, on the model of Plato's demiurge or the creator in *Genesis*.[32] One need not take a position on the vexed question of how Aristotle's theology relates to his natural philosophy to grasp that he nowhere describes the divinity as planning or designing the activities of the lesser creatures that inhabit the cosmos. Sublunar life is similar to superlunar life not because God has commanded it to be so, but due to the accidental corruption of aether below the moon. In general, Aristotle seems to think of the life-activities, and hence the goals, of sublunar creatures as stemming, not from a grand design, but from the limited abilities of sublunar creatures to participate in everlasting life.

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[29] *De caelo*, 292b17-19.

[30] Ibid., 292b19-22.

[31] Ibid., 292b22-23.

[32] For an account of Aristotle's debts to, and rebellion from, Plato's global teleology, see David Sedley, "Teleology, Aristotelian and Platonic," in *Being, Nature, and Life in Aristotle*, eds. J. G. Lennox, and R. Bolton, 5-29 (Cambridge: Cambridge University Press, 2010).

What are the consequences of this interpretation of Aristotle's teleology? First, sublunar teleology, while not reducible to the self-motion of simple bodies, depends on the teleology of superlunar substances. The corruptibility of sublunar matter entails that numerical identity over time is impossible for sublunar creatures, and thus gives them purpose. Second, the grounds for Aristotle's cosmic teleology are wholly a priori. For his conception of sublunar creatures' final ends being conditioned by eternal motion rests on the idea that those superlunar substances with inherent circular motion are prior to them and more complete. While Aristotle does not offer an analysis of the meaning of completeness in *De caelo*, he generally considers a substance to be complete when "as regards its inherent excellence (τῆς οἰκείας ἀρετῆς) it lacks no part of its natural magnitude."[33] On this reading, the completeness of superlunar beings is necessarily axiological, in the sense that these beings "lack nothing" of their own nature, constantly achieving their purpose, whereas all other creatures' purposes must be derived by reference to them. Thus, while empirical observation could reveal a final cause, teleological attributions are ultimately justified by comparison to the perfect activity of superlunar substances. Aristotle's doctrine of final causes is not an empirical thesis, but a consequence of his axiological conception of the universe as a descent from beings that display perfection. This conception of perfection is axiomatic in Aristotle's philosophy of nature.[34]

## IV. Descartes' ontology of nature

I have been arguing that Aristotle's ontology of natural substances depends on the notion that every sublunar creature has a characteristic, imperfect self-motion that is teleological insofar as it is an imitation, in a corrupted body, of the perfect and eternal motion of superlunar substances. Insofar as he banishes final causes from physics, Descartes' physics clearly represents a "modernizing" break from Aristotle and the scholastic tradition. Yet there is disagreement as to what we should take the fundamental motive and effect of this rupture to be. Are Descartes' laws, as exemplified in his reduction of circular motion to rectilinear conatus rehearsed in the opening section, merely an alternative to Aristotelianism, or do they represent a fundamental shift to an ontology of nature that informs and justifies the seventeenth-century Scientific Revolution?

Supporters of the latter view have argued that Descartes' physics represents a "mathematization of nature" or a "geometricization of space," in which natural objects are understood in purely mathematical terms, that

[33] Aristotle, *Metaphysics*, 1021a22-23.

[34] For Aristotle's notion of "axiom," see *Posterior Analytics*, 72a14-17.

is, with reference only to the propositions of geometry and the primitive concepts of extension and motion. As Koryé puts it, Descartes' universe is

> a strictly mathematical world, a world of geometry made real about which our clear and distinct ideas give us certain and evident knowledge. There is nothing else in this world but matter and motion; or, matter being identical with extension, nothing else but extension and motion.[35]

According to Koryé, Descartes' rejection of teleology is intimately related to his mathematization of nature, and of the consequent "reduction" of physics to mathematics. Some more recent treatments of Descartes' natural philosophy, however, argue that these interpretations tend to make dubious appeals to textual evidence.[36] Against this mathematizing interpretation, Ariew has argued that Descartes accepts that corporeal things are divisible, have shape, and are in motion "not because they are geometrical or mathematical, but because they are modes of extension that can be distinctively known."[37] In this view, although the geometry can be used to describe corporeal bodies insofar as they are extended, read in his proper context, Descartes makes no commitment to the objects of nature being essentially mathematical.

Although this debate could be stated in terms of substantive philosophical questions about the connection between mathematics and physics in Descartes' system, or as a hermeneutical question concerning which texts should be privileged in interpreting Descartes' views, one need not appeal to the *Rules* or to Descartes' biography or education to grasp his ontology of the natural object. In the *Discourse*, Descartes reports that in his unpublished treatise, *The World*, he founded the laws of nature in his own, rational theology.

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[35] Alexandre Koryé, *From the Closed World to the Infinite Universe* (Baltimore: The Johns Hopkins Press, 1957), 100-101. Koryé's view is an extension of Husserl's conception of the "geometrization of his nature" accomplished in early modern physics to the work of Descartes. See Edmund Husserl, *The Crisis of European Sciences and Transcendental Phenomenology: An Introduction to Phenomenological Philosophy*, trans. D. Carr (Evanston: Northwestern University Press, 1970), 28-42; and Justin Humphreys, "Husserl's Archaeology of Exact Science," *Husserl Studies* 30 (2014): 101-127 for a discussion of Husserl's conception of mathematized science.

[36] Roger Ariew, *Descartes and the First Cartesians* (Oxford: Oxford University Press, 2014), 131-37, argues that appeals to the conception of *mathesis universalis* in Descartes' *Rules* can lead to a mistaken impression of the relationship between Descartes's mathematics and his physics. The *Rules* are an immature work, which remained unpublished in Descartes' lifetime, and had virtually no influence on the subsequent development of the physics. When we look to Descartes' main work on physics, the *Principles*, it seems that mathematics mainly serves as a model of clear and distinct perception in the sciences.

[37] Ariew, 136-137.

> I revealed what were the laws of nature; and basing my reasoning on no other principle than the infinite perfections of God, I set out to prove those laws about which one might have had some doubt, and to show that they are such that even if God had created many worlds, there could not be any in which they could have failed to be observed.[38]

If we understand invariance across hypothetical, possible worlds to indicate necessity, Descartes' claim is that the metaphysical necessity of the laws of nature rests on the perfections of God. Thus, the question of the relationship of Descartes' ontology of the natural object to mathematics rests on his theology.[39]

This derivation of the laws to which every object must conform from the perfections of God is carried out in the *Principles*, in which Descartes recognizes three fundamental laws of nature.

> [I] Each and every thing, in so far as it can, always constitutes in the same state; and thus what is once in motion always continues to move.[40]
> [II] All motion is in itself rectilinear; and hence any body moving in a circle always tends to move away from the center of the circle which it describes.[41]
> [III] If a body collides with another body that is stronger than itself, it loses none of its motion; but if it collides with a weaker body, it loses a quantity of motion equal to that which it imparts to the other body.[42]

The first law follows from the immutability of God: "We understand that God's perfection involves not only his being immutable in himself, but also his operating in a manner that is always utterly constant and immutable."[43] What is the logical connection between God's immutability and the conservation

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[38] René Descartes, *Ouvres de Descartes*, eds. Ch. Adam, and P. Tannery (Paris: Vrin/C.N.R.S., 1964-1976), VI, 43.

[39] See Daniel Garber, *Descartes' Metaphysical Physics* (Chicago: The University of Chicago Press, 1992) for discussion of the development and reception of Descartes' principles of physics.

[40] Descartes, VIIIA, 62. The translations here are those of John Cottingham, Robert Stoothoff, and Dugald Murdoch, *The Philosophical Writings of Descartes* (Cambridge: Cambridge University Press, 1985).

[41] Descartes, VIIIA, 63.

[42] Ibid., VIIIA, 65.

[43] Ibid., VIIIA, 62.

of motion? Descartes' point can be understood counterfactually: if motion in the universe were not conserved, God's operation of creation would be inconstant or mutable. But God's operations are constant and immutable. Therefore, motion must be conserved. The conservation of inertia is therefore derived from God's perfection of immutability.

The second law is derived almost in the same way as the first. Because the operation by which God preserves motion in matter is immutable and simple, every moving object has a direction at an instant and would continue moving in that direction unless acted upon by an external force. As Descartes puts it, God "always preserves the motion in the precise form in which it is occurring at the very moment when he preserves it."[44] Consequently, any deviation from rectilinear motion would violate God's simplicity, and thus must be attributed to interference by an external force.

The derivation of the third law occurs in two parts. First, Descartes distinguishes between motion and direction, in order to note that an object's change in direction does not entail any change in the total motion of the system. This is not an appeal to a theological principle but a conceptual distinction. Second, Descartes argues that it is by means of immutability of God's actions that "the world is preserved through an action identical with its original act of creation."[45] Descartes concludes his discussion of the third law with the comment that the continual change that can be observed in creation is evidence of the immutability of God.

These arguments play multiple roles in Descartes' philosophical system. Metaphysically, they ground Descartes' dynamical laws in the perfections of God. Epistemologically, they suggest a "natural theology" according to which empirically verifiable conservation laws point to the existence of a cosmic architect, whose continuous creation of the universe is explanatory of physical regularities that can be spelled out in mathematical terms. Indeed, while Descartes third law is false, the first and second laws are simply assumed – without appeal to theology – in Newton's laws of motion.[46] The ground for Descartes' principles is not empirical observation of corporeal bodies, but a wholly a priori conception of the perfections of God.

Descartes' theological foundation of the laws of physics underwrites a conception of natural objects that leaves no room for the Aristotelian separation of the heavens and the earth. Whereas for Aristotle, sublunar and superlunar creatures are of a fundamentally different nature, the Cartesian conception requires that the universe be completely uniform in its motions.

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[44] Ibid., VIIIA, 64.

[45] Ibid., VIIIA, 66.

[46] See Gary Hatfield, *The Routledge Guidebook to Descartes' Meditations* (New York: Routledge, 2014), 62-65, 307.

Thus, the apparent circularity of heavenly motions to which Aristotle attached such importance is reduced to a mere appearance to be accounted for by the mathematics of rectilinear motion and resistant forces. The same foundation entails that there is no real self-motion for Descartes. Rather, apparently independent motions of different object must be caused by the transfer of the fixed amount of motion established in God's original creative act. As a result, there is no meaningful way in which a Cartesian could understand the imitation of heavenly motions by earthly creatures. Aristotelian teleology, like the apparent self-motion it is meant to explain, is thereby excluded from the Cartesian cosmos. Thus, while Descartes does not self-consciously conceive of his ontology as a mathematization of nature, his theological foundation of physical law produces a physics that presents itself as the geometry of a uniform space of extended objects.

I have argued for the somewhat counterintuitive thesis that the inclusion of final causes in physics depends on an axiological but not necessarily theological view of nature, whereas the exclusion of final causes is at root based on a theological doctrine. It is remarkable, then, that Aristotle and Descartes both derive their principles in natural science from what are at base aesthetic judgments about the perfection of nature. For Aristotle, nature is assumed to be perfect in that its best part – the outer spheres of the heavens – is engaged in an immutable and eternal motion that is imitated in the imperfect motions down here. Though Descartes denies any real distinction between circular and rectilinear motion, he remarkably argues for the uniformity and rectilinearity of the motions of the universe on an aesthetic basis quite similar to that of Aristotle. Like Aristotle, Descartes accepts that a perfect being must be eternal, simple, and immutable in its actions. The main difference appears to be that while Aristotle attributes perfection directly to the superlunar sphere, Descartes attributes it to the transcendent creator of the universe, denying the distinction between the sublunar and superlunar parts of the cosmos. The metaphysical basis of the division between Aristotelian natural philosophy and Cartesian natural science thus rests on a decision concerning whether to locate perfection within the whole, perceptible universe, or whether to refer it to a supersensible divinity. This suggests that an essential determinant of Descartes' modernizing conception of nature is a Christian theology according to which God produces nature so that his creatures might come to know his perfection.

## V. Conclusion: Competing aesthetics

Aristotle and Descartes both appeal to aesthetic criteria to establish their fundamental physical principles. By designating these criteria, and the judgments from which they stem, as aesthetic, I do not mean that they are necessarily

arbitrary or "in the eye of the beholder."[47] Rather, I mean that they are normative judgments that are underdetermined by any amount of empirical evidence. Neither is Aristotle's judgment that there are grades of perfection, in which lower substances imitate more perfect higher substances, nor Descartes' view that God alone is perfect, his creatures merely being signs of his perfection, the sorts of theses that could be confirmed by observation. In both cases, perfection indicates a kind of completeness and beauty, but any standard of what is perfect will necessarily be independent of judgments made within natural science. Although they agree on little else, Aristotle and Descartes both hold that physics must be established on axioms that originate outside of physics.

Aristotle's physics is based on the idea that natural objects are good when they achieve their intrinsic ends. This is possible only if they can move themselves in such a way as to achieve those ends. His doctrine of motion is thus based on an aesthetic vision of the universe in which each part has its own proper goal and activity. Descartes denies that bodies could have intrinsic ends or move themselves. Thus, while he accepts that motion is the mode of extended substance, he denies that bodies must be active realizers of distinctive types of motion. Rather, Descartes grounds his principles of motion in the perfections of God, holding that a perfect being must be the source of all motion, and will continue to ensure the consistency of that motion at every instant. While Descartes argues that we cannot know God's purposes, he calls on his aesthetic grasp of God's perfections to posit indubitable grounds for mathematical physics.

Aside from its historical interest, this divergence is notable because it marks an exclusive disjunction: either a natural object has or does not have an intrinsic principle of motion. Aristotle's teleological theory has the drawback of assuming one can know the purpose of natural objects. In *Meditation* IV, Descartes argues that this is impious, objecting that searching for final causes depends on the false assumption that we can know the purposes of God.[48] But if Aristotle's conception of nature comes at the cost of a hubristic epistemology, it has the metaphysical benefit of allowing for real indeterminism. Aristotle's views that everything has a cause and that no future event in the sublunar world is necessary are consistent precisely because he understands sublunar creatures to be self-movers.[49] Descartes, by denying intrinsic motion to creatures, risks a

[47] I thank an anonymous reviewer for pressing me to clarify the meaning of "aesthetic" in this context.

[48] Descartes, VII, 55.

[49] For discussion of Aristotle's indeterminism, see Elizabeth Anscombe, "Aristotle and the Sea Battle: *De interpretatione*, Chapter IX," in *The Collected Philosophical Papers of G. E. M. Anscombe*. Volume I: From Parmenides to Wittgenstein, 44-55 (Oxford: Basil Blackwell, 1981), 45-48.

determinism according to which no motion is spontaneously produced. Thus, in the *Meditations*, he identifies freedom with the will, and says that it is in virtue of this that one bears an image and likeness of God.[50] The Aristotelian problem of how a creature can move itself is transformed into the Cartesian problem of mental causation. Freedom is, in this account, located not in the living animal body, but in the human mind. Yet insofar as this freedom is human freedom, the possibility of an indeterminate future is identified with the problem of evil, and once again justified on theological grounds. The universe is more perfect as a whole because some of its parts are not immune from error, while others are infallible.[51]

Why does a ball released from a sling travel in a straight line, rather than continuing on its circular path? For Aristotle, were the ball composed of aether rather than of water and earth, it would have continued in its circular path eternally. Grasping the ball's corrupted, sublunar nature makes clear why its path must be rectilinear and finite. For Descartes, its motion is explained by principles I and II, which in turn are justified by the perfections of God. In other words, the ball's conatus is just a shorthand for the conserving activity of a perfect being. But is it not curious that, having rejected Aristotelian natures and the teleology implied by them, that Descartes must use a conception of natural "striving" to make his physical theory conceptually tractable? Clearly, conatus cannot indicate an intrinsic principle of motion, since that has been excluded from Descartes' system. Instead, I think, it must be Descartes' placeholder for God's ineluctable will or tendency to maintain a coherent system of rectilinear motion. Conatus is thus the name for the retreat from Aristotelian teleology into Cartesian theology.

One might have expected that the conception of a purposeful universe would be linked to the idea of a creator God who guarantees the good of his creatures. Yet, on the contrary, I have argued that the teleological conception was not explicitly theological, but merely required that the activities of nature have intrinsic value. Rather, the conception of a purposeless and inanimate universe that can only correctly be described by mathematics is the accomplishment of a monotheistic worldview, that puts every perfection in God and leaves no space for lower grades of perfection in his creatures.

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[50] Descartes, VII, 57-58.

[51] Ibid., VII, 61.

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