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Late-scholastic and Cartesian *conatus*

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Introduction

Conatus ("striving") is a specific concept within Descartes's physics. In particular, it assumes a crucial importance in the purely mechanistic description of the nature of light – an issue that Descartes considered one of the most crucial challenges, and major achievements, of his natural philosophy. According to Descartes's cosmology, the universe – understood as a material *continuum* in which there is no vacuum – is composed of a number of separate yet interconnected vortices. Each of these vortices consists in a set of bands rotating around their centres. The bands are composed of corpuscles of the three elements, each distinguished on the basis of their different shapes and sizes. The small globules of the second element (of which the heavens are mainly composed), although impeded by the other parts of heaven, strive to move away from the centre of the vortex around which they revolve, thus exerting a certain force against the surrounding bodies. This striving or *conatus*, though a mere force rather than a genuine motion, is transmitted instantaneously and along straight lines from body to body. According to Descartes, then, the nature of light consists in this striving alone.

This account must be understood as strictly connected to the fundamental laws that regulate the Cartesian world. It is particularly important to recall that for Descartes the centrifugal force exerted by a rotating body is understood to be a consequence of the intrinsic rectilinearity of every motion. As the second of the three Laws of Nature set forth in Book II of the *Principles of Philosophy* establishes, "all motion is in itself rectilinear; and hence any body moving in a circle tends to move away from the centre of the circle which it describes ("*tendere* semper ut recedat a centro circuli quem describunt") as proved by the fact that a stone rotating in a sling tends to move centrifugally along the tangent of each point described by a circle.[1] Similarly, each of the globules of the second element "strives to recede with a great force from the centre of the vortex in which it rotates; it is in fact prevented by the other globules placed all around, not differently than a stone in a sling".[2] Within this framework, as I show later, *conatus* occurs when a body's intrinsic tendency to rectilinear motion is impeded by an external constraint.[3]

As Stephen Gaukroger notes, the use of the term *conatus* in the *Principles* – like "vis" and "action" – shows that Descartes "cannot avoid dynamic terminology", despite his declared intent "to construe motion in a purely kinematic way". Indeed, Gaukroger observes that the notions of force (*vis*) action (*actio*) and striving (*conatus*) are systematically employed in the *Principles* – appearing 290, 59 and 8 times, respectively.[4] Also noteworthy, *conatus* was – together with the more familiar concepts of *actio* and *vis* – a significant element of the conceptual apparatus of Scholastic natural philosophy. As will be seen later – and this is the first goal of this

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paper – here the concept of *conatus* had a very specific function. Indeed, it was a central part of the Aristotelian-Scholastic account of gravitation. *Conatus* was used to refer to the striving of a body to move towards its natural place – especially in cases where its natural motion was hindered or impeded by an external mover.

This specific use of the concept of *conatus* can be found in texts on natural philosophy from the end of the sixteenth through the late seventeenth century. Notably, it occurs in some of the late-Scholastic texts which held special significance for Descartes's thought. Therefore, Descartes introduces *conatus* in a context in which this concept already had a very specific meaning, and one of which he was very probably aware. The possible relations between these two apparently very different concepts have therefore to be scrutinized. I thereby propose to undertake a comparison between the Scholastic and the Cartesian conceptions of *conatus*. I hope to show that certain traits of the former are indeed echoed by the latter, although adapted to the much changed physical paradigm of Cartesian physics.[5] In fact, Descartes's *conatus*, though sharing some important similarities with the old one, underwent significant transformations in terms of both its meaning and its application. However, I hope to show that these concepts are both used to describe the behaviour of bodies in relation to their intrinsic motive tendency, and in particular when this tendency is impeded or prevented.

Such a reconstruction offers two main areas of interest. On an immediate level, it furthers the general efforts of scholars over the past decades to reconstruct the full extent of the relations between Descartes's thought and Scholastic philosophy. However, there is another significant reason for taking an interest in the ties between the Scholastic and the Cartesian conceptions of *conatus*. Indeed, the Cartesian *conatus* must be seen as crucial to a proper understanding of the broader, diverse conceptualization that this idea enjoyed in the thought of many of the most important philosophers of the early modern period, namely Spinoza, Hobbes and Leibniz. In particular, Spinoza (and probably Hobbes too), were directly influenced by Descartes in their unique formulations of *conatus*. Thus a reconstruction of the context in which Descartes formulated his *conatus* and of its relations to a pre-existing Scholastic conception will enable us to better reconstruct the history of this idea in the early modern period.

The paper is structured as follows: in the first part, I provide a thorough review of the Scholastic employment of the concept *conatus* – both its meaning and the extent of its usage. I then show that it occurs in some of the most prominent Cartesian sources. Finally, I shall provide an account of Descartes's theory of circular motion and *conatus* with the specific aim of emphasizing the elements of both continuity and discontinuity that justify the claim that Descartes's conception of *conatus* is reminiscent of the Scholastic one.

Conatus in scholastic physics

As is well known, one of the bases of Aristotelian physics consisted in the crucial distinction between "natural" and "violent" motions. In a notorious passage of his *Physics*, Aristotle argued that:

> upward locomotion belongs naturally to fire and downward to earth, and the locomotions of the two are certainly contrary to each other. And again, fire moves up naturally and down unnaturally; and its natural motion is certainly contrary to its unnatural motion. Similarly with remaining: remaining above is contrary to motion from above downwards, and to earth this remaining comes unnaturally, this motion naturally. So the unnatural remaining of a thing is contrary to its natural motion, just as we find a similar contrariety in the motion of the same thing: one of its motions, the upward or the downward, is natural, the other unnatural.[6]

All sublunary motions eventually culminate in a state of rest, rest being the natural state of every thing. In this theoretical framework, "natural" motion was understood as the one directing

a thing to its natural place or sphere. Heavy bodies were thought to "gravitate" by falling rectilinearly towards the centre of the earth. Levitation – although in late-Scholasticism often understood as a mere by-product of gravitation – occurs in light bodies (such as fire), which are attracted upwards to their natural sphere. On the other hand, "violent" motion was understood as any motion imparted by an external mover that displaced a body from its state of rest, or that forced the body to assume a motion whose direction diverted it from its rectilinear, natural motion towards the centre of the earth. *Gravitas* and *levitas* were understood as resulting from the form of the body or to the form of the elements composing it.[7]

The obscurity of the causes of gravitation often resulted in these phenomena being described in language which was associated with animate beings. Psychological terms, for example, were employed systematically, albeit analogically, to describe natural phenomena, such as those of levitation of gravitation. For instance, the relations of attraction or repulsion between inanimate entities were often described in terms of "desire" or "aversion". A good example of this is the use of the term "appetite" (*appetitus*). For instance, Aquinas, in his *Summa contra Gentiles* (probably written in 1264) distinguishes three possible uses of the term:

> there is in everything an appetite for the good: for good is what everything desires [*appetuntur*], as the philosophers teach. In this way, the appetite in the things that lack thought is called natural appetite, as for instance it is said that the stone desires [*appetit*] to be downwards. In those who have sensitive thought, it is called animal appetite, which is divided into concupiscible and irascible. In those who have intelligence, it is called intellectual or rational appetite, which is will.[8]

Similarly, the entry for *appetitus* in Goclenius's *Lexicon Philosophicum* (1613) distinguishes three proper usages (*naturalis appetitus*, *animalis appetitus* and *appetitus naturae intelligentis & voluntariae*). Goclenius himself underlines the "ambiguous nature of the term", pointing out that there is said to be an "appetite" of "fire to occupy the superior places, of the iron to conjoin with the magnet; of plants to absorb lymph, of horses to venery, of men to beatitude".[9] *Naturalis appetitus* – a usage that Goclenius describes as somewhat inappropriate[10] – applies both to "plants who attract toward themselves and desire aliments without sensibility",[11] and to "inanimate things, such as the magnet".[12] In the jargon of late Scholastic physics, then, *appetitus* is a well-established concept, specifically employed to describe a thing's attraction towards its natural place. The awareness of the psychological connotation of the term did not cause any reluctance in respect of its use. Rather, it raised the need for further clarification in certain instances. Francesco Buonamici, in his *De Motu* (1587) to give one example, justified the somewhat "metaphorical" use of the term *appetitus* by providing a general definition of it as the "inclination which is necessary from the nature of every thing to agree to the good that convene to itself according to nature".[13]

Conatus – a word that in Latin signifies "striving" and therefore has anthropomorphic or psychological connotations – was a part of this lexicon. Indeed, as mentioned, the concept of *conatus* was a central part of the Scholastic account of gravitation. Every sublunary body has a tendency to return to its natural place through a rectilinear motion towards the centre of its sphere. Whenever it is displaced from its natural place, or, in particular, whenever its natural motion towards the centre of its sphere is impeded or hindered by an external, violent motion, the body exerts a force. This force was interpreted as a genuine striving to move towards the body's natural place; to put it differently, a body's effort to move according to its intrinsic motive tendency. It is important to note that *conatus* was not understood as actual motion, but simply as a striving to move.

One could provide many examples of the peculiar use of this concept. For one, William A. Wallace, in his *Prelude to Galileo,* recalls the concise definition of *conatus* provided by the

Jesuit scholar and apologist Muzio Vitelleschi in his lectures on Aristotle's *Physics*.[14] Vitelleschi addressed himself to one of the *vexatae quaestiones* of Scholastic gravitational theory, that is, whether heavy or light bodies gravitate or levitate in their own spheres. As Wallace recalls,

> to answer this Vitelleschi notes that natural motive powers have three different effects: (1) they move to a proper place when nothing impedes them; (2) they provide a certain tendency [*quidam conatus*] to motion if something impedes them; and (3) they keep the element in its proper place, resisting any attempt to remove it therefrom. […] Vitelleschi's position is that if by gravitation is understood the element's remaining in its proper place and resisting any effort to be removed from it, then one can say that the elements gravitate within their own spheres. But if gravitation is understood properly for a motion downward or for a *conatus* to such motion, then the elements do not gravitate – a fact that explains why we do not feel the weight of the air with which we are surrounded.[15]

According to Vitelleschi, *conatus* occurs when the natural motive tendency of a body is impeded. It is therefore the dynamic manifestation of the intrinsic kinetic tendency that each sublunary body has towards its natural place. A similar understanding can be found in the *Commentari in Octo Libros Physicorum Aristotelis* of the Jesuit Collegium Conimbricenses, first published in 1592, but still very influential in the first decades of the seventeenth century (as its numerous reprints attest). According to these Jesuit scholars, the violent motion impressed on a stone by throwing it upwards gives rise to a striving in the stone to move by its natural motion towards the centre of the earth. This striving can be seen as a force that actively opposes the ascent of the stone.

> every time a stone is thrust upwards by an external force, its form opposes the ascent by a natural striving [*conatu*] and impulse that urges it downwards; but also the water, when warmed up by the fire, repels actively this form of warmness, because of an innate tendency to cold, and to conserve its coldness as much as it can, even in fire).[16]

As noted by Cees Leijenhorst, Eustachius a Sancto Paulo makes use of the notion of *conatus* in his *Summa* (1626). From Eustachius's accounts, it becomes evident that *conatus* is a force exerted by a body to move naturally, but does not itself constitute motion. In fact, Eustachius carefully distinguishes the striving from the actual state of gravitating or levitating. He writes:

> Wherever they are, the heavy bodies which are above light ones fall down [*gravitant*], as well as the heavier which are over the less heavy ones. Similarly, the light bodies that are amongst heavy ones, and the lighter ones amongst less light ones, rise. The truth of this claim is evident from experience: indeed, everywhere heavy bodies are set down, immediately the light or less heavy ones, if they are below, are carried up to a higher place. And this would not happen if it were not for the reciprocal strivings [*conatu*] of the heavy bodies to descend, and of the light ones to ascend, which in act [*actu*] are called gravitating and levitating.[17]

Similarly Francesco Buonamici, author of a famous treatise on motion (*De Motu,* written in 1587 and published in 1591) which is likely to have exerted some influence on the young Galileo (who at the time was Buonamici's pupil in Pisa) makes frequent use of the concept of *conatus*. For instance, in Book V of *De Motu*, an exhaustive examination of violent motion, Buonamici explains that the mover, in order to move a body, must first overcome the resistance of the body to remain in a state of rest. In this case, the *conatus* of the body does not assist the motion imparted by the mover in any way. Whereas the contrary applies when I throw a stone downwards, since in this case the *conatus* contributes to the motion imparted by the external mover:

> Thus everything opposes its destruction as much as it can; for this reason it is so far from accelerating, that unless the force of the moving body were to exceed the resistance of the movable body, that body would never move; and unless the violent faculty prevails, it would always come back to its previous place; nor would it assist the striving of the moving body in any way, as it would with the stone, if they let it fall with a great impetus.[18]

It is possible to find occurrences of this peculiar usage of the concept of *conatus* in the second half of the seventeenth century. An example is found in the *Tractatus de motu locali physicus* (1646) of the Jesuit mathematician Honoré Fabri. Fabri's *De motu,* traditionally seen merely as an example of the reaction of the late Scholastics to Galileo, has recently been re-evaluated to shed light on the originality of its conception of impetus.[19] In Book X, again devoted to violent motion (understood by Fabri as opposed to natural motion, also called "formal motion" since he conceives it as dependent upon the form of the body), he addresses a set of objections against his theory of impetus, among which is that "when a hand bears a certain body motionlessly, it does not produce any impetus".[20] Fabri replies:

> I answer that no impetus is in vain. And it may be that it lacks motion, as one can observe in this innate impetus, whose effect is twofold: that is, gravitation and motion, as we have indicated elsewhere. Similarly, the impetus produced by a motive power […] may have a twofold effect. The first is motion; the second is an exertion [*nisus*] or striving [*conatus*] opposed to the extrinsic motion. […] Indeed it always has this innate motion, unless it is hindered by another body […].[21]

What Fabri calls "extrinsic motion" (*extrinsecus motus*) is nothing but the effect of an external mover that impedes the fulfilment of a body's intrinsic motive tendency. This external hindrance causes the body to exert a certain striving to move naturally.

Despite the fact that it is written in Italian, we also find an echo of the Scholastic conception of *conatus* understood as a proof of the validity of Aristotle's account of gravitation in the Jesuit Stefano degli Angeli's dialogue on gravity, *Della gravita' dell' aria e fluidi esercitata principalmente nelli loro homogenei* (1671). Since the form of a body determines its gravity (that is, the force with which it is attracted towards the centre of his sphere) degli Angeli argues that if the heaviness of a certain portion of matter is diminished, its *conatus* will decrease proportionally. Therefore, it will be pushed upwards by the rest of matter that has preserved its gravity intact:

> A portion of this water or air shall be made in a certain way a bit less dense and heavy, so that its striving to descend [*il suo conato al discendere*] diminishes partially; you will observe that it would be immediately pushed upwards by that air, or water, that, being unaltered, keeps the same *conatus* [*conserua il medemo conato*] that exceeds that of the rarefied […].[22]

Similarly, Giovanni Alfonso Borelli, in his *De motionibus naturalibus a gravitate pendentibus* (1670), makes a systematic and frequent use of the term *conatus*, understood again as the force exerted by a body when prevented from gravitating. This is indicative of the diffusion of this particular use of the concept of *conatus* beyond the frame of Aristotelian physics. For instance, in the second set of hypotheses in Book I – devoted to the motion of the sublunary bodies in a fluid medium – Borelli writes that:

> In the second place I suppose a force, or a striving [*conatum*] with which it strives to unite itself with the terraqueous sphere, accomplished through a line straight in respect to the surface of the horizon. And this is manifest since any body strives [*conatur*] with a natural instinct to reach the centre of earth in the shortest way. Therefore the direction of the aforesaid motion, or compressive striving [*conatus*] is produced along the semidiameters of the same earth, that is, those that are constructed on the

> horizontal surface, which enclose spherically the earth itself, and therefore is evident that motion or the compressive striving of every part of the fluid is produced along lines perpendicular to the horizon.[23]

This passage allows us to underline another important characteristic of the Scholastic conception of *conatus*, namely its directional nature. Since heavy bodies are attracted to the centre of the earth, their motion tends rectilinearly in that direction. Therefore, as Borelli clarifies, the *conatus* of heavy bodies is oriented perpendicularly with respect to the horizon.

Conatus in Cartesian sources

It is hard to determine the origin of the concept of *conatus* within Scholasticism. However, it seems at least possible to claim that its usage spreads especially among late Scholastic authors, since I have not found any attestation of it in some of the most representative of the ancient sources of Aristotelian natural philosophy.[24] Its frequent (but not universal) occurrence in Jesuit commentaries or treatises may suggest that this concept could have been developed in this specific *milieu*, and then rapidly spread due to the pre-eminent role held by the Jesuit order in the educational system of the time.[25] It is also necessary to emphasize that, despite its arguably wide diffusion, there was no fully systematic use of the *conatus* concept in Scholastic natural philosophy, nor in the various systems of post-Scholastic early modern physics.[26]

Whatever the origin of this concept might have been, it is certainly possible to argue that Descartes was very likely familiar with at least two of the possible sources of the Scholastic conception of *conatus*. In fact, both the Conimbricenses *Commentaries* on Aristotle's works and Eustachius's *Summa* were likely adopted as textbooks at the Jesuit college of La Flèche where Descartes was educated, or at least commonly circulated in that milieu. As Dennis Des Chene has highlighted, Descartes himself recalled in a letter to Mersenne (30 September 1640)[27] that he had read these texts during his youth, and he expressed his intention to return to them in order to anticipate the possible objections of the Jesuits to his *Meditations*.[28] Moreover, as Roger Ariew has noted[29] in another letter to Mersenne (11 November 1640) Descartes praises Eustachius's "Philosophie" (probably referring to his *Summa quadripartita*) as "the best book that has ever been written on this subject". Descartes writes that he intends to take it as a model for a publishing project, along with a "Cours de ma Philosophie en forme de Theses", of a "Cours de la Philosophie ordinaire".[30] It seems clear, then, that Descartes knew Eustachius's philosophy quite well, and some scholars have claimed that he was probably influenced by it at least to a certain extent.[31] By extension, therefore, it is quite feasible to argue that Descartes was familiar with the Scholastic concept of *conatus* through these sources.

Circular motion and *conatus* in Descartes's physics

However, the fact that Descartes was probably aware of the use of *conatus* within Scholastic natural philosophy does not allow *per se* any speculation on a possible influence of this concept on Descartes's own conception. On the contrary, the Scholastic *conatus* is *prima facie* very far from Descartes, since it is tied to an account of gravitation that Descartes harshly criticizes. Indeed, Cartesian physics is based precisely on a rebuttal of the Aristotelian account of gravitation, and therefore on a refutation of the doctrine of natural places. Gravitation, in his view, could not be ascribed to obscure, hylomorphic principles, nor described tautologically in terms of attraction and appetite. As Descartes writes,

> Those who have not followed Aristotle […] have nevertheless been saturated with his opinions in their youth (since they are the only opinions taught in the Schools) and this has so dominated their outlook that they have been unable to arrive at knowledge of true principles. Although I respect all these thinkers […] they have all put forward as principles things of which they did not possess perfect knowledge. For example, there is no one of them, so far as I know, who has not supposed there to be weight in terrestrial bodies. Yet although experience shows us very clearly that the bodies we call 'heavy' descend towards the center of the earth, we do not for all that have any knowledge of the nature of what is called 'gravity', that is to say, the cause or principle which make bodies descend in this way, and we must derive such knowledge from some other sources.[32]

Bodies do not tend to any natural place, as to understand them as such is to rely on tautological and obscure heuristic principles. Moreover, motion is not a contingent, teleologically oriented state, taking place between an initial and eventual condition of rest (or, to put it as the Scholastics did, having a *terminus a quo* and *ad quem*). On the contrary, Descartes's physics is based on the assumption that "God is the primary cause of motion; and He always preserves the same quantity of motion in the universe."[33] From this follows a set of three laws, called by Descartes "Laws of Nature". The first of these laws is the exact overturning of the very basis of Aristotelian natural philosophy. In fact, Descartes claims that "each and every thing, insofar as it can, always continues in the same state; and thus what is once in motion always continues to move", as well as to stay at rest and keep its shape.[34]

Therefore, the Scholastic and the Cartesian concepts of *conatus* are not only applied to different phenomena, but are also deeply rooted in very different theoretical frameworks that make them difficult to compare. However, as I shall show, both these concepts concern the explanation of the intrinsic motive tendency of bodies, and in particular the description of the behaviour of these bodies when their intrinsic motive tendency is impeded.

As we have seen, according to Descartes every motion is intrinsically rectilinear. Circular motion, on the contrary, is the outcome of the combination of external constraints that hinders the body from moving along a straight line. The second law (II, 39) as recalled, consists in the establishment of rectilinearity as the only intrinsic determination of motion.[35] Descartes claims that "all motion is in itself rectilinear; and hence bodies moving in a circle always *tend* to move away from the centre of the circle which they describe" ("*tendere* semper ut recedant a centro circulo quem describunt").[36] The verb "tendere" which Descartes uses here is strictly connected to the *conatus* concept. Indeed in his earlier work *The World* (originally written in French between 1629 and 1633 but published posthumously in 1664), Descartes clarifies the use of the verb "tendre" ("to tend)" which he uses in the explanation of the same law of nature (although here it is his third, rather than his second law). "Tending" implies the idea of striving ("effort", the French equivalent of the Latin *conatus*) which is the consequence of a certain external *resistance*.[37] The expression "tendre", says Descartes, implies that a body

> is disposed to move there, whether it truly moves or, rather, some other bodies prevents it from doing so. It is principally in this last sense that I use the word *tend*, because it seems to signify some *effort* and because every effort presupposes some *resistance* [c'est principalement en ce dernier sens que je me sers du mot de *tendre*, à cause qu'il semble signifier quelque *effort*, & que tout effort présupose de la *resistence*][38]

Immediately after, while explaining the nature of light as due to the striving of the corpuscles of the second element in their rotation around their vortex, Descartes specifies that "the *resistance* of other parts of heaven" against the rectilinear tendency of the corpuscles of the second element causes them to move circularly and so to *tend* centrifugally, and that it is "the reason why they make an *effort* to move (est cause qu'elles font *effort* pour se mouvoir')".[39] The concept of tendency therefore already implies a certain external constraint that opposes the intrinsic rectilinear

inertia of a body, and at the same time the *force* that this body exerts to put into action the rectilinear motion.[40] Descartes's *conatus* is, therefore, to be understood as a dynamic (rather than a kinetic) expression of the intrinsic rectilinearity of motion. Indeed, *conatus* takes place when a body is forced to move circularly, and therefore when its intrinsic rectilinearity of motion is prevented – a condition that is to be considered as the norm in a *continuum* where there is no vacuum, and where therefore bodies are in a state of perpetual mutual collision and constraint.

The intrinsic rectilinearity of motion is founded on the same metaphysical assumption as the principle of the preservation of states established in the first law. As Descartes explains, it is due to "the immutability and the simplicity of the operation by which God preserves motion in matter". Indeed,

> [God] always preserves the motion in the precise form in which it is occurring at the very moment when he preserves it, without taking any account of the motion which was occurring a little while earlier. It is true that no motion takes place in a single instant of time; but clearly whatever is in motion is determined, at the individual instants which can be specified as long as the motion lasts, to continue moving in a given direction along a straight line, and never in a curve[…].[41]

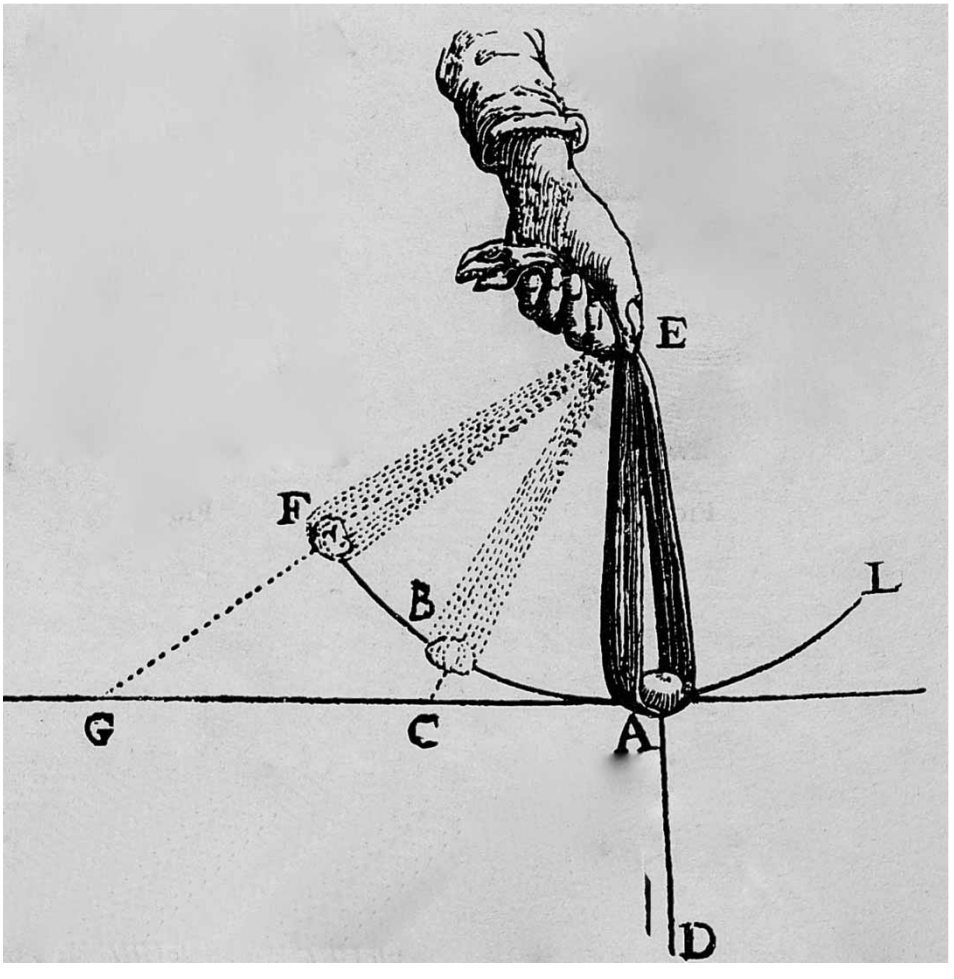

Figure 1. The centrifugal, tangential tendency of the stone rotating in a sling as represented by Descartes in the *Principles*.

Therefore, continues Descartes (see Figure 1)

> the stone A, rotating through the circle ABF in the sling EA, in that instant, in which it is in the point A, is determined to move toward a certain part namely along a straight line toward C, in such a way that the straight line AC is the tangent of the circle. And one cannot pretend that it is determined to any curved motion. Even if it previously arrived from L to A along a curved line, nothing however of this bending can be understood to remain in it, while it is in the point A. And this is also confirmed by experience since in the instant it leaves the sling, it does not continue to move toward B, but toward C. From this, it follows that every body that is moved in a circle always tends to recede [*tendere ut recedat*] from the centre of the circle that it describes.[42]

As Peter McLaughlin has underlined, Descartes's three laws describe the behaviour of bodies in the ideal (but we may also say merely theoretical) case of the "absence of interactions", or in the case in which "two otherwise isolated bodies […] interact with each other – and *only* with each other" and are therefore "neither impeded nor assisted' by surrounding bodies".[43] In fact, since Descartes considers the *res extensa* as a *continuum*, in which "each body is simultaneously in contact with many others".[44] How does the complexity of nature harmonize with the simplicity of God's action? In *Le Monde*, Descartes's position is very explicit: God's action on nature is simple and constant. Therefore, the extreme complexity of natural phenomena cannot be seen as the immediate result of his action; rather, they must be attributed to nature:

> by "nature" I do not here mean some deity or other sort of imaginary power. Rather, I use that word to signify matter itself, insofar as I consider it taken together with all the qualities that I have attributed to it, and under the condition that God continues to preserve it in the same way that He created it. From that alone (i.e., that He continues thus to preserve it) *it follows of necessity that there may be many changes in its parts that cannot, it seems to me, be properly attributed to the action of God (because that action does not change) and hence are to be attributed to nature*. The rules according to which these changes take place I call the "laws of nature".[45]

And, a little further on, Descartes even adds that the variety of motions in nature is to be understood as *accidental*:

> with God always acting in the same way and consequently always producing the same effect in substance, there occur, as *by accident* [*comme par accident*] many diversities in that effect. And it is easy to believe that God, who, as everyone must know, is immutable, always acts in the same way.[46]

In this light, curvilinear or circular motion cannot be interpreted as an immediate consequence of God's action on nature. The intrinsic tendency of moving bodies, indeed, is to maintain their rectilinear motion. This tendency derives from the very action of God on nature. Curvilinear or circular motion is therefore a mediate consequence of this constant action of preservation, in other words, a supervenience on the interaction of this simple and constant divine action with the complex and chaotic essence of the extended substance. In fact, as Descartes puts it, "God alone is the author of all the motions in the world, *insofar as they exist and insofar as they are straight*, *but it is the diverse disposition of matter that renders the motions irregular and curved*."[47] Surprisingly, Descartes even compares rectilinear tendency and human agency. He writes:

> the theologians teach us that God is also the author of all our actions, insofar as they exist and insofar as they have some goodness, but it is the diverse disposition of our wills that can render those actions evil.[48]

As good actions are said to be dependent on God whereas evil actions depend on the limitations of our will, so God can be considered responsible for the motion of a body only insofar as it takes place along a straight line. It would be indeed not hard to glimpse here, in this account of rectilinear inertia as an outcome of the simple action of God's ordinary concourse on nature, an echo of the Aristotelian distinction between natural and violent motion. Circular motion is always the outcome, though indirect, of the fundamental kinetic behaviour of bodies. However, it is no doubt that here Descartes intends to emphasize the difference between the intrinsic rectilinearity of the motion of bodies and the various motions – and especially the circular ones – deriving from the complex constitution of extended substance. In this account, circular motion must be considered as the outcome of a complex combination of multiple causes that act simultaneously on the same body. As Descartes explains in III.57, a stone rotating in a sling effectively tends to move circularly, but only "if we consider all the causes which go to determine its motion, since it in fact goes in this direction".[49] In fact, if we abstract all the different determinations that affect that stone – or, as Descartes puts it, "if we concentrate simply on the power of moving which is in the stone itself" – we shall notice that it tends simultaneously to exert from the rotating centre along a tangent described from each point of its circumference, and from each of the radiuses of the same circumference. However, explains Descartes, "although the sling prevents this effect, it cannot however prevent the striving" ("ac quamvis funda hunc effectum impediat, non tamen impedit conatum").[50]

The *conatus* is not a mere abstract determination, but is considered by Descartes to be an actual force, so much so that he even understands it as measurable to a certain extent. Descartes explains in the *Principles* (see Figure 2) that if we put a ball in a tube, then apply a circular motion to the tube, we observe that the ball will move towards the extremity of the tube with increased speed, since the initial force will be increased by the striving from the centre of the rotation:

> in a first moment, in which this tube is put in rotation around the centre E, the ball A moves toward Y only with a very slow movement; but in a second moment it goes on a bit quicker: in fact, it will retain the previous force, and will then acquire a new one from a new striving to recede from the centre E.[51]

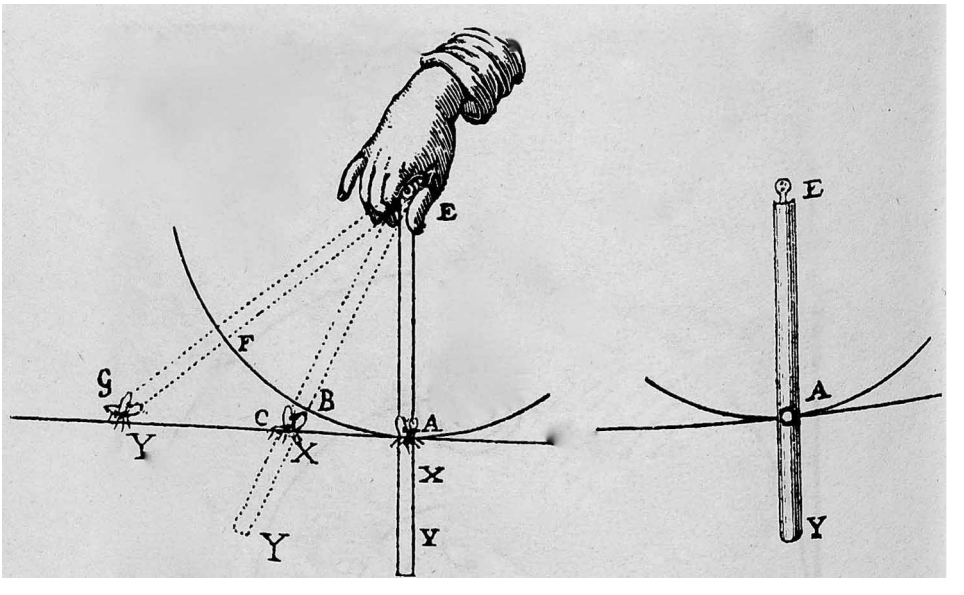

Figure 2. The tube rotates and the ball contained in it moves towards its extremity with increasing speed. Another representation of the conatus offered by Descartes in the *Principles*.

Similarly, Descartes observes that there is an increased tension in the cord which holds the projectile which corresponds to a faster rotational motion applied to the stone in a sling. Therefore, "this tension, arising from the only force with which the stone strives to recede from the centre of its motion shows us the quantity of this force".[52]

Conclusions

In a famous passage in the *Principles*, Descartes clarifies that his use of the expression "striving" does not entail any suggestion of animation:

> when I say that the globules of the second element 'strive' to move away from the centres [*recedere conantur ab istis centris*] around which they revolve, it should not be thought that I am implying that they have some thought from which this striving proceeds. I mean merely that they are positioned and pushed into motion is such a way that they will in fact travel in that direction, unless they are prevented by some other causes (II, 56).[53]

The main aim of this passage was probably that of wiping out any possible charge of endorsing the animistic interpretation of natural phenomena that had characterized some of the most important natural philosophies of the Italian Renaissance, such as those of Bruno, Patrizi and Campanella. No less important, however, this clarification can be seen as a veiled polemic against the ambiguous employment of psychological expressions that, as I have shown, characterized Scholastic natural philosophy.

The very fact that Descartes uses the expression "recedere conantur ab istis centris" despite a seeming dissatisfaction with its vaguely voluntaristic connotations, can be seen as evidence of the fact this expression is taken from a pre-existing context in which it carried a highly specified meaning that was relatively close to that which Descartes was looking for. Indeed, the Cartesian *conatus* seems to be reminiscent of some traits of the Scholastic one. The Cartesian body, when forced to move curvilinearly and so prevented from moving according to its rectilinear intrinsic tendency – an expression of the simplicity of the divine ordinary concourse – strives to move in that direction. In other words, the *conatus* manifests the intrinsic motive tendency of the body in the presence of external resistance. According to the Scholastics, a sublunary body – especially when it is prevented from moving naturally towards the centre of its sphere or when this natural motive tendency is opposed by an extrinsic motion – strives to move in that direction. A *conatus* – which again is not motion but merely a striving towards motion – manifests this intrinsic motive tendency of the body. Moreover, both the Scholastic and the Cartesian *conatus* are not actual motion but forces (although we have to take into account the very different meaning that this implied in their respective conceptual frameworks), and both are exerted rectilinearly (although the former tends in a single direction to the centre of its sphere).

In both cases, *conatus* is part of the explanation of how bodies behave in relation to their intrinsic motive tendencies. What changes – and dramatically – is the consideration of what an intrinsic motive tendency is, and therefore which forces are to be taken as indicative of this intrinsic motive tendency. In the Aristotelian framework, the gravitational attraction exerted by the earth's mass for bodies near its surface is interpreted as due to the natural tendency of bodies to move towards the centre of their sphere. When I hold a heavy body in my hand, I perceive a force that pushes downwards because the body strives to move naturally towards the centre of its sphere. On the contrary, in Descartes's account the experience that can actually display the intrinsic motive tendency of bodies is that of a projectile rotating in a sling. If I release the projectile, it continues its motion rectilinearly and tangentially to the circle that it describes, and not circularly. The centrifugal force I perceive when I rotate a projectile in a sling is given

because the projectile *strives* to move rectilinearly, that is, according to the motion that God imparts to it with his ordinary concourse.

However, these similarities rest on a general conception of nature that is dramatically, or better, paradigmatically, changed. In this respect, an important part of Descartes's work consisted in the redefinition of a whole arsenal of Scholastic concepts to fit his new mechanistic framework, and the reworking of the concept of *conatus* that I have laid out here was central to this transformation.

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Notes

1. Descartes, *Principles of Philosophy*, 39, 240–1; Latin taken from Descartes, *Principia Philosophiae*, in *Oeuvres*, 63.
2. Descartes, *Oeuvres*, 112: "unusquisque satis magna vi recedere conetur a centro vorticis in quo gyratur: retinetur enim hinc inde ab aliis globulis circompositis, non aliter quam lapis a funda" (my translation).
3. In defining a body's motive tendency as "intrinsic", I do not imply that for Descartes motion is a property of things. For, as I better show later, according to Descartes it depends on God's action only. However, there is no doubt that Descartes considers rectilinear motion as the kinetic state that a body has *quantum in se est*, that is, independently from any external constraint or hindrance. It is in this sense that I use the expression "intrinsic motive tendency" or equivalent variants.
4. See Gaukroger, *Descartes's System of Natural Philosophy*, 108.
5. In his book *The Mechanization of Aristotelianism*, Cees Leijenhorst connects Hobbes's conception of *conatus* with its use in late-Scholasticism: "Hobbes' reinterpretation of the Aristotelian concept of *conatus* is another expression of his 'continental' rejection of active forces and inner potentialities. Although rejecting the scholastic theory of gravity and free fall, he retained the concept of gravity as an inclination, a striving, or what the scholastics call a *conatus*. His only quibble concerned the way scholastics defined the term. According to Hobbes, *conatus* cannot be an intrinsic, non-kinematic principle by which bodies move themselves. In his mechanism, all physical action is local action. This, if *conatus* is indeed physical action, it must be motion. It cannot be a mere potentiality to move, as the scholastics had it. In Hobbes' view, *conatus* is not an appetite to move, but actually motion itself." Leijenhorst, *The Mechanisation of Aristotelianism*, 196.
6. Aristotle, *Physics*, 10–21, in *The Complete Works of Aristotle*, 92.
7. For an account of the Scholastic theory of motion, see Maier, *Studien Zur Naturphilosophie Der Spätscholastik*.
8. Aquinas, *Summa contra Gentiles*, 2 http://www.corpusthomisticum.org/scg2046.html (accessed 24 May 2013): "Inest enim omnibus appetitus boni: cum bonum sit quod omnia appetunt, ut philosophi tradunt. Huiusmodi autem appetitus in his quidem quae cognitione carent, dicitur naturalis appetitus: sicut dicitur quod lapis appetit esse deorsum. In his autem quae cognitionem sensitivam habent, dicitur appetitus animalis, qui dividitur in concupiscibilem et irascibilem. In his vero quae intelligunt, dicitur appetitus intellectualis seu rationalis, qui est voluntas."
9. Goclenius, *Lexicon Philosophicum*, 114: "Distinctio ambigae verbi naturae. Appetitus ὁμονύμω dicitur: In igne ad occupanda loca superiora:in ferro ad sui conjunctionem cum magnete: in planta ad humore sugendum: in equo ad Venerem: in homine ad beatitudinem."

10. Ibid., 115: "qui dicitur quodammodo improprie appetitus," "that is somewhat improperly called aid somewhat inappropriately appetite", (my translation).
11. Ibid.: "in stirpe, quae attrahit & appetit alimentum absque sensu […]."
12. Ibid.:"In inanimis, ut magnete".
13. Buonamici, *De Motu*, 392:"Ergo appetitus definitio talis afferri poterit, inclinatio necessaria ex natura cuiusq. rei ad bonum sibi coveniens secundum naturam".
14. See Vitelleschi, *Lectiones R. P. Mutii Vitelleschi in octo libros*.
15. Wallace, *Prelude to Galileo*, 116.
16. Conimbricenses, *Commentari in Octo Libros*, V.6, *Explanatio*, 202 (my translation): "quandoquidem lapis externa vi sursum propellitur, reluctatur ascensui eius forma naturali conatu, & impulsu, quod deorsum nititur; sed etiam aqua ab igne calefit, eius forma calefactioni active repugnat, per ingenitam ad frigus inclinationem, et quantum potest frigum suum active conservando, et in igne."
17. Eustachius, *Summa*, P.3, P2, Q6, 121 (my translation): "Corpora gravia supra levia, aut graviora supra minus gravia ubicunque sint gravitant: similiter levia infra gravia, aut leviora infra minus levia levitant. Cujus assertionis veritas experientia constat: ubicunque enim gravia ponuntur, confestim superiorem locum levibus aut minus gravibus, si haec infra sint, deferuntur, quod non sit, nisi mutuo gravium descendentium, levium ascendentium conatu, qui gravitandi et levitandi actu nuncupantur."
18. Buonamici, *De motu*, V.35, 503: "Ideo quod unumquodque suae neci resistit, quantum potest; tantum abest ut eo properet, ut nisi virtus moventis resistentiam mobilis superet nunquam moveatur; et nisi prevaleat facultas violans, in pristinum locum semper retrocedat; neque ullo modo conatum moventis adiuvat, sicut adjuvaret saxum, si magno impeto deiicerunt […]."
19. See for instance Roux, "La Philosophie Naturelle," 75–94, and Palmerino, "Two Jesuit Responses to Galileo's Science of Motion," 181–227.
20. Fabri, *Tractatus physicus*, 417, (my translation): "Decimò, cum manus ſuſtinet aliquod pondus immobiliter, non producit in eo impetum."
21. Ibid.: "Respondeo omnem impetum non esse frustrà, licèt careat motu, vt patet in ipso impetu innato, cuius duplex est effectum; scilicet grauitatio, & motus, vt aliàs iam indicauimus; similiter impetus productus à potentia motrice, […] potest duplicem effectum; primus est motus; secundus est nisus seu conatus oppositus extrinseco motui; […] enim innatus semper habet motum, nisi impediatur ab alio corpore […]."
22. degli Angeli, *Della Gravità*, 10 (my translation): "Vna portione di quest'acqua, ò aria sia resa per qualche accidente vn pochino meno densa, e graue, sìche il suo conato al discendere ceda in parte; vederà, che subito sarà spinta in sù da quell'altr'aria, ò acqua, la quale essendo inalterata, conserua il medemo conato, il quale eccede quello della rarefatta. […]."
23. Borelli, *De motionibus naturalibus*, (Cap. 1, supp. II, 11 (my translation): "Secundo loco suppono vim, seù conatum, quo fluida nituntur sese vnire sphæræ terraqueæ, effici per lineas erectae ab superficiem horizontis. & hoc patet quia quodlibet graueis naturali instinctu conatur ad centrum terræ accedere via breuissima, igitur directio prædicti motus, seù conatus compressiuus efficietur per semidiametros eiusdem terræ, hæ verò erectae sunt ab superficiem horizontalem, quæ sphæricè ipsam terram comprehendit, igitur manifestum eſt quòd motus seù conatus compressiuus omnium partium fluidi per lineas ab horizontem perpendiculares efficitur."
24. For instance, there is no mention of the *conatus* in Averroes (*Aristotelis Libri Physicorum 8*) Buridan (*Subtilissimae Quaestiones Super Octo Physicorum Libros Aristotelis*), Nicolaus Oresme (*Nicolaus Oresmes Kommentar Zur Physik Des Aristoteles*,) or Duns Scotus (*In VIII. Libros Physicorum Aristotelis Expositio et Quaestiones.*)
25. There is no explicit use of the concept in Toletus (*Francisci Toleti Commentaria*) nor in the Complutenses commentaries on Aristotle's *Physics* (*Disputationes in Octo Libros Physicorum Aristotelis.*)
26. For instance, there is no mention of this specific use of the concept in Borro (*De Motu Grauium, & Leuium*) in Cardano (*Opus novum de proportionibus*) Giovanni-Battista Benedetti (*Diversarum Speculationum Mathematicarum*), Galileo Galilei's *De motu antiquiora*, Giovanni Battista Baliani (*De Motu Naturali Gravium Solidorum*,) or Andreas van Berlicom (*Elementorum de rervm natvralivm gravitate*).
27. Descartes, *Correspondence*, 185.
28. Des Chene, "Descartes and the Natural Philosophy of the Coimbra Commentaries," In *Descartes's Natural Philosophy*, edited by Stephen Gaukroger, John Schuster, and John Sutton, London: Routledge, 2000, 29: "Descartes mentions the commentaries of the Coimbrans only twice in his correspondence. In 1640, anticipating objections by the Jesuits to the *Meditationes,* and having some desire 'to re-read a bit of their Philosophy', he asks Mersenne to send him the names of the authors 'whom they

follow most closely'. Wondering whether anything new has appeared in the last twenty years, Descartes adds that he recalls 'only the Coimbrans, Toletus, and Rubius'; he also remembers, but not by name, 'a Chartreuse or Feuillant' who wrote an *abrégé* of 'the whole School Philosophy'. That author turned out to be Eustachius a Sancto Paulo, and it was to Eustachius' *Summa quadripartita,* which is indeed a greatly condensed compilation of other philosophers' works, that he eventually turned."

29. Ariew, *Descartes among the Scholastics*, 43–4.
30. See Descartes, *Correspondence*, 232: "J'ay achepté la Philosophie du frere Eust. à sacto P., qui me semble le meilleur livre qui ait iamais esté fait en cette matiere; ie seray bien aise de sçavoir si l'autheur vit encore' and ibid., 233: 'Et mon desire est d'écrire par ordre tout un Cours de ma Philosophie en forme de Theses […]; & au mesme livre, de faire imprimer un Course de la Philosophie Ordinaire, tel que peut estre celuy du Frere Eustache, avec mes Notes à la fin de chaque question, où iiadjousteray les diverses opinions des autres, & ce qu'on doit croire de toutes, & peut-estre ò la fin ie feray une comparaison de ces deux Philosophies."
31. On this, see Van De Pitte, "Some of Descartes's Debts."
32. Descartes, *Oeuvres*, 183.
33. Ibid., 36, 240.
34. Ibid., 35, 240–241.
35. However, Stephen Gaukroger (has underlined that there are at least two passages in which Descartes seems to admit circular inertia (Gaukroger, "The Foundational Role of Hydrostatics and Statics", 60–1). Gaukroger attributes this apparent contradiction to a "structural ambiguity" of Descartes account of motion, due to the fact that "Descartes models his kinematics on statics, and particularly on hydrostatics." (ibid. 62).
36. Descartes, *Principles of Philosophy*, 241; Latin from *Oeuvres*, 63.
37. The Cartesian concept of resistance has been regarded by scholars as intimately connected to that of conatus. Since the treatment of this connection goes beyond the goal of this paper, I limit myself to recall the account of resistance as *active persistence* provided by Dennis Des Chene. Accordingly, "In Descartes's thinking […] persistence can be regarded under a negative or a positive aspect. Negative persistence is the permanence of a state *in the absence of* external causes. I will call this simply *persistence*. […] Positive persistence is the permanence, or the tendency to permanence, of a state, *in the face of* external causes. This I will call *resistance*. Although Descartes's first law asserts only that a thing will persist, in his second and third laws it is clear that a thing will also resist certain kinds of external cause. Resistance […] was construed by some authors to be passive, by others as active, or, more specifically, reactive. That ambiguity remains in Descartes's physics, and […] its underground survival helps to explain why he formulated the rules of collision so as to created a marked asymmetry between motion and rest.(see Des Chene, *Physiologia,* 273–74)" Nevertheless, it is worthy to note that here in *The World*, differently from the *Principles*, the resistance is merely understood as *the external constraint* that prevents the actual rectilinear movement of the body (for instance, the sling for what concerns the stone or the corpuscles or the other parts of heaven for what concerns the corpuscles of the second element rotating around the centre of their vortex.)
38. Descartes, *Le Monde*, 146–7.
39. Ibid., 151 (emphasis added).
40. The meaning of the concept of force in Descartes is a point of contention among scholar. The dispute concerns in particular the relation between force and bodies. Indeed, some scholars (see for instance, Gueroult and Gabbey in Gaukroger, *Descartes: Philosophy, Mathematics and Physics*) have claimed that force is to be understood as an actual property contained *in* bodies, whereas others have seen it as a consequence of the action of God on matter. For instance, Daniel Garber claims that "the force Descartes appeals to in Law 3, and the tendency a body has to persevere in its state derive from God, from the immutable way in which he sustains the world he creates, in particular, from the way in which he sustains the body in motion in that world. In this way force is not *in* bodies themselves. (see Garber, "Descartes's Physics," 320.)"
41. Descartes, *Principles of Philosophy*, 242.
42. Descartes, *Oeuvres*, 64: "Lapis A, in funda EA per circulum ABF rotatus, eo instanti, quo est in puncto A, determinatus quidem est ad motum versus aliquam partem, nempe secundam lineam rectam versus C, ita scilicet ut linea recta AC sit tangens circuli. Non autem fingi potest illum determinatum esse ad ullum motum curvum: etsi enim prius venerit ex L ad A per lineam curvam, nihil tamen istius curvitatis intelligi potest in eo remanere, dum est in puncto A. Hocque etiam experientia confirmatur, quia si tunc e funda egreditur, non perget moveri versus B, sed versus C. Ex quo sequitur, omne corpus quod

circulariter movetur, perpetuo tendere ut recedat a centro circuli quem describit. (My translation).” NB The standard English edition of the *Principles* does not provide a full translation of the text. Therefore, I will supply my own translations from the Latin when it is necessary, providing the original passage in the notes.

43. See McLaughlin, “Force, Determination, and Impact,” 85–6.
44. Descartes, *Principles of Philosophy*, 248.
45. Descartes, *The World*, 59, (my italics).
46. Ibid., 59–61.
47. Ibid., 75, (my emphasis).
48. Ibid.
49. Descartes, *Principles of Philosophy*, 260.
50. Descartes, *Oeuvres*, 109 (my translation. Emphasis added).
51. Ibid., 111: “primo quidem temporis momento, quo iste canalis agetur in gyro circa centrum E, globulus A motu tantum tardissimo progredietur versus Y; sed secundo momento paulo celerius incedet: priorem enim vim retinebit, ac praeterea novam acquiret a novo conatu recedendi a centro E […], (my translation).”
52. Ibid., 112: “ista tensio, a sola vi qua lapis recedere conatur a centro sui motus exorta, exhibet nobis istius vis quantitatem,” (my translation).
53. Descartes, *Principles of Philosophy*, 259; Descartes, *Oeuvres*, 108.

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