X. Descartes' Physics in *Le Monde* and the Late-Scholastic Idea of Contingency.

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After reconstructing some fetures of the Scholastic treatment of contingency in natural philosophy, this paper draws a comparison between Descartes' treatments of the issue of the laws of nature in *Le Monde* (1629-1633) and in the *Principles of Philosophy* (1644). On the basis of this comparison, it argues that elements of the Scholastic understanding of contingency as due to the impediment provided by matter are still present in the former. While in the *Principles* Descartes appears to equate contingency with an epistemological limitation in our understanding of the complexity of natural phenomena, in the conclusion I argue that some elements of his previous approach to the issue remains in his treatment of curvilinear motion.

§1. Introduction.

By the second half of the seventeenth century, most inquirers became increasingly convinced that whatever happened in the universe—excluding the activity that originated from the immaterial, human soul—stemmed necessarily from the efficient interactions between bodies. In this framework, contingency predominantly became an epistemological issue: if a phenomenon cannot be reduced to a more general law or rule, this meant that the explanatory framework that was applied to its investigation was insufficient. Ultimately, then, contingency became something that concerned the limits—regardless whether considered intrisic and unavoidable, or provisional and surmountable—of our knowledge, rather than something intrinsic to nature itself.

Despite some studies that have emphasized a connection between theological voluntarism—that is, the idea that natural phenomena, being always susceptible of being changed by God's power, are essentially contingent—and empiricism on the one hand, and of intellectualist theology—that is, the idea that some eternal truth, such as natural laws or geometrical properties, are eternal and unchangeable—and method on the other, such a shift towards an epistemological appreciation of contingency seems to have involved both parts equally.[1] In the *Ethics* (1676), Spinoza, after having

[1] In *Divine Will and the Mechanical Philosophy*, on the basis of an analysis of Gassendi's and Descartes' natural philosophies and methodologies, Osler claimed that the adhesion to intellectualist and voluntarist theology was at the root of the emergence of divergent "scientific styles"—rationalism and empiricism respectively (see Osler 1994). An implication of this claim is that, since Gassendi believed the order of nature to be contingent on God's will, first causes cannot be solidly sized and therefore man shall rely solely on empirical knwoledge. However, as Osler

stated that "[i]n nature there is nothing contingent, but all things have been determined from the necessity of the divine nature to exist and to produce an effect in a certain way" (I, 29),[2] equated contingency with a defect of our knowledge:

> …a thing is called contingent only because of a defect of our knowledge. For if we do not know that the thing's essence involves a contradiction, or if we do know very well that its essence does not involve a contradiction, and nevertheless can affirm nothing certainly about its existence, because the order of causes is hidden from us, it can never seem to us either necessary or impossible. So we call it contingent or possible. (I, 33 Schol. I).[3]

Though underpinned by a mild voluntarism,[4] claims of such kind can be also found, for instance, in the works of Robert Boyle. In his 1686 *A Free Enquiry into the Vulgarly Received Notion of Nature,* Boyle, while maintaining that God can intervene in human affairs through his special providence, suggested that the apparent irregularities that we observe in nature are due to our limited power to understand the providential design of God and the order he imposed on nature.[5] In this framework, apparent "aberrations" or "irregularities" are, he intimated, likely the

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recognized, Gassendi emphasized (also in reaction to Epicurus' notion of chance) the presence of a natural order due to God's general providence (see 54-55). Moreover, his assessment of the issue of fortune appears to rule out the presence of merely contingent events in the world, for he attributes the cause of fortuitous events to concourses of causes that, while unaccountable to men, are known to the eye of God (See Gassendi, 1964, 840: "Quippe dici uno verbo potest, licere tam Fatum, quam Fortunam defendere, si concesseriums Fatum esse Voluntatis divinae decretum, praeter quod nihil omnino fiat; Fortunam vero concursum, vel eventum esse, qui cum improvisus hominibus sit, provisus tamen a Deo fuerit; & ipsi causarum, seu Fati seriei innexus […] Ex quo vides, cum vox Fortunae ex ante dictis, duo indicet, concursum causarum, & praeviam ignorationem eventus; posse Fortunam propter posterius, hominum respectu, non Dei, admitti; & propter prius, nihil obstare, quo minus dicamus Fortunam partem esse non modo Fati, sed divinae etiam Providentiae, quae tam praevisa hominibus, quam non praevisa complectatur.") This is also in line with what Gassendi's medieval theological and philosophical sources (at least those identified by Osler) ultimately claimed. As Roques clarifies in chap. 3 of this book, medieval voluntarists, though emphasizing God's power to change the course of nature at any moment, contended that, eventually, such possibility was mostly virtual. It follows that statements on the contingency of the natural world were mostly independent from the inquirer's concrete approach to the study of nature. Moreover, as noted by Wilson (1997) in her review of *Divine Will*, Osler's claim infers a connection between Gassendi's and Descartes' theological beliefs and their epistemological approaches, though there is no causal connection between the belief that God is more or less bounded to his creation and the idea that we can or cannot obtain a priori knowledge of nature. Wilson's claim about the lack of connection between theological and epistemological stances is corroborated by Harrison's analysis of Newton voluntarism. See Harrison (2004),; Harrison also claims that the categories of voluntarism and intellectualism were not as defined in the early modern period as they were in the Middle Ages, but that, on the contrary, they tended to blur. See Harrison (2002).

[2] Spinoza, *(*1985), 433.

[3] Ibid.,, 436.

[4] Boyle (1996), 101: "…I think it becomes a Christian philosopher to admit in general that God does sometimes in a peculiar, though hidden way, interpose in the ordinary phenomena and events of crises; but yet that this is done so seldom, at least in a way that we can certainly discern, that we are not hastily to have recourse to an extraordinary providence - and much less to the strange care and skill of that questioned being called nature - in this or that particular case, though perhaps unexpected, if it may be probably accounted for by mechanical laws and the ordinary course of things."

[5] ibid.,, 101: "…it seems more allowable to argue a providence from the exquisite structure and symmetry of the mundane bodies, and the apt subordination and train of causes, than to infer from some physical anomalies that things are not framed and administered by a wise author and rector. For the characters and impressions of wisdom that are conspicuous in the curious fabric and orderly train of things can with no probability be referred to blind chance, but

result of our incapability to recognize them as the result of their "genuine causes": reconduct them to their "genuine causes":

> … I think it very possible that an artificer of so vast a comprehension and so piercing a sight as is the maker of the world might, in this great automaton of his, have so ordered things that divers of them may appear to us, and as it were break out abruptly and unexpectedly, and at great distances of time or place from one another, and on such accounts be thought irregular; which yet really have, both in his preordination and in the connection of their genuine causes, a reference that would, if we discerned it, keep us from imputing it either to chance or to nature's aberrations.[6]

Using the popular comparison between nature and a mechanical clock (and perhaps inspiring the Voltaire of *L'univers m'embarrasse, et je ne puis songer/ Que cette horloge existe et n'ait pas d'horloger*)[7], Boyle claimed that if a Chinese king was shown by Jesuit missionaries a clock with an alarm set at a particular time of the day, he would think that the alarm was likely due to a disorder in its mechanism, whereas, on the contrary, he would have recognized it as its regular feature had the clock been set to chime each hour:

> let us consider that if, when the Jesuits that first came into China presented a curious striking watch to the king, he that looked to it had wound up the alarm so as to strike a little after one; if (I say) this had been done, and that these Chinese that looked upon it as a living creature or some European animal, would think that when the index pointing at two of the clock likewise struck the same hour, and so three, four and onward, they would judge that these noises were regularly produced, because they (at equal intervals of time) heard them, and whensoever the index pointed at an hour, and never but then. But when the alarm came unexpectedly to make a loud, confused and more lasting noise, they could scarce avoid thinking that the animal was sick or exceedingly disordered. And yet the alarming noise did as properly flow from the structure of the little engine, and was as much designed by the manager of it, as those sounds of the clock that appeared manifestly regular.'[8]

Focusing on the elements of necessity of the course of natural phenomena, and identifying elements of apparent irregularity with the limitations of the explanatory framework applied to it, this approach to the issue of contingency revised a long-standing tradition. Also motivated by the necessity of harmonizing natural causality and free agency, Scholastic natural philosophers paid great attention to the problem of contingency. As nicely summarized by Anneliese Maier in her *Die Vorläufer Galileis im 14. Jahrhundert* (1949), they generally maintained that natural agents were

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must be [ascribed] to a most intelligent and designing agent. Whereas on the other hand, besides that the anomalies we speak of are incomparably fewer than those things which are regular and are produced in an orderly way; besides this, I say, the divine maker of the universe being a most free agent and having an intellect infinitely superior to ours, may in the production of seemingly irregular phenomena have ends unknown to us, which even the anomalies may be very fit to compass."

[6] Boyle, 101.

[7] Voltaire (1772), 9.

[8] Boyle, 102–3.

"causae determinatae," that is, determined to act necessarily by their forms towards a certain end.[9] On the contrary, free agents or "agens ob intellectu" were seen as undetermined in their causes, and therefore their actions were deemed to be intrinsically contingent.[10] According to their formal determination, all natural phenomena thus seemed necessitated. However, natural agents simultaneously appeared contingent in another way, that is, according to the effective actualization of their formal determination. To take the example of gravitation, a stone is necessarily determined by its form to fall towards the centre of the earth. This determination does not appear contingent to any extent. However, accidental circumstances can well prevent this action from taking place: a stone may be impeded in its fall by external circumstances. Therefore, even if its formal determination is necessary, the actualization of this determination is contingent.[11]

The Scholastic characterization of contingency in the natural, sublunary world derives from the Aristotelian definition of possibility provided in the *Prior Analytics*. According to Aristotle, possibility can be attributed to things happening "for the most part," as well as those things happening by chance.[12] This distinction is crucial for understanding Aristotle's conception of science. Differing from mathematics, sublunary physics is characterized by regularity, not necessity. In fact, sublunary phenomena are subject to a certain degree of unpredictability and uncertainty. This degree of unpredictability is due precisely to the contingency characterizing sublunary physics. Aristotle maintained that scientific knowledge can only obtained for those things happening necessarily or for the most part, thus excluding phenomena happening by chance.

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[9] Maier (1949).

[10] Ibid., 222-223: "Jede anorganische Ursache, jedes "agens a natura" wirkt nach Aristoteles mit Notwendigkeit, d.h. immer und immer in derselben Weisen, ein agens libere (ein agens ab intellectu) dagegen mit Kontingenz derart, daß es unter gleichen Bedingungen einen Effekt hervorbringen oder nicht hervorbringen kann. Es ist das ein fundamentaler Unterschied zwischen den beiden Gruppen von wirkenden Kräften, die die Scholastik unterscheidet: die einen sind causae determinatae, die mit mechanischer Notwendigkeit auf ein bestimmtes Ziel hinwirken und immer wirken (oer wenigstens immer zu wirken besteht sind), während die andern causae intederminatae sind, die ceteris paribus mit einer "contingentia ad utrumlibet" wirken oder nicht wirken können."

[11] Ibid., 223: "…neben dieser Kontingenz der Freiheit gibt es für die Scholastik noch eine zweite, nämlich eine Kontingenz der natürliche Ereignisse. Bei dieser handelt es sich nicht um die Modalität des agere auf Seiten des Ursache, sondern um die Modalität des fieri auf Seiten des Effekts. Denn obwohl jedes agens naturale mit Notwendigkeit wirkt, tritt der Effekt nicht immer mit Notwendigkeit ein, sondern kann per accidens durch andere Ursachen oder durch die mangelnde Disposition im patiens oder sonst irgendwie vereitelt werden. In diesem Fall spricht man von "kontingenten" Ereignissen, wobei das Wort Kontingenz nicht mehr die Undeterminiertheit des Wirkens, sondern die Unsicherheit im Zustandekommen der Wirkung bezeichnet. Der Gegensatz zu dieser Kontingenz ist die Modalität derjenigen Effekte, die schlechthin immer und unvermeidlich eintreten, wenn die sie anstrebenden Ursachen gegeben ist."

[12] Aristotle (2014), 18: "Having made these distinctions we next point out that 'to be possible' is used in two ways. In one it means to happen for the most part and fall short of necessity, e.g. a man's turning grey or growing or decaying, or generally what naturally belongs to a thing (for this has not its necessity unbroken, since a man does not exist forever, although if a man does exist, it comes about either necessarily or for the most part). In another way it means the indefinite, which can be both thus and not thus, e.g. an animal's walking or an earthquake's taking place while it is walking, or generally what happens by chance; for none of these inclines by nature in the one way more than in the opposite" (I, 32b4-32b13).

According to this view, the regularity of sublunary phenomena merely allows generalization and inference.[13] Crucial to this description is Aristotle's notion of impediment (ἐμπόδισμα), which would go on to constitute an important trait of the late-Scholastic characterization of contingency. Aristotle believed that the motion of natural things is characterized by their principle or ἀρχή. While most of these motions reach their natural end, others are impeded by extrinsic factors from doing so.[14] In this framework, while physical phenomena are mostly regular, irregularities can nevertheless often occur, or, as Aristotle puts it, "[i]n natural products the sequence is invariable, if there is no impediment."[15] In Scholasticism (and in pre-modern natural philosophy more generally), this latter form of contingency was commonly defined as "contingentia ut plurimum". According to this conceptualization, contingentia ut plurimum (that is, contingency concerning things happening for the most part) characterized phenomena of the sublunary world in the sense that they could be *impeded* by external constraints. More specifically, in Aquinas' conceptualization, what makes a thing contingent or necessary is not the actual presence, or absence, of the impediment which limits the activity of the natural thing and the achievement of its final determination. Rather, it is the possibility itself that this impediment is present that makes the phenomenon intrinsically contingent.[16] Such a conceptualization, although not homogeneously, can be found in a number of authors and lexica still in the seventeenth century.[17]

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[13] "Science and demonstrative deductions are not concerned with things which are indefinite, because the middle term is uncertain; but they are concerned with things that are natural, and as a rule arguments and inquiries are made about things which are possible in this sense. Deductions indeed can be made about the former, but it is unusual at any rate to inquire about them (Ibid., 32b14-32b22)."

[14] "[...] those things are natural which, by a continuous movement originated from an internal principle, arrive at some end: the same end is not reached from every principle; nor any chance end, but always the tendency in each is towards the same end, if there is no impediment (*Physics* II, 199b14-199b18)." 33.

[15] Ibid.

[16] One can find an influential example of the conception of contingency in Scholasticism in Thomas Aquinas's commentary to Aristotle's Physics. Here, Aquinas characterizes contingent phenomena as those that can be impeded, in contrast with necessary ones, which cannot impeded at all. He says: "… someone defines to be necessary what does not have any obstruction; and also contingent for what concerns things that happen for most part as what can be impeded in few occasions. But this is not correct. Indeed, they say necessary is defined as what by nature cannot not be; contingent or for the most part, what can not be. Rather, what can have or not have impediment is contingent. Nature indeed does not dispose an impediment for what cannot not be, for this would be superfluous [Sciendum etiam quod quidam definierunt esse necessarium, quod non habet impedimentum; contingens vero sicut frequenter, quod potest impediri in paucioribus. Sed hoc irrationabile est. Necessarium enim dicitur, quod in sui natura habet quod non possit non esse: contingens autem ut frequenter, quod possit non esse. Hoc autem quod est habere impedimentum vel non habere, est contingens. Natura enim non parat impedimentum ei quod non potest non esse; quia esset superfluum (In Physic., lib. 2 l. 8 n. 4. [...]$^{-2}$ Ed. *Corpus Thomisticus*)]."

[17] This definition of contingentia ut plurimum is commonplace in Scholastic natural philosophy. To give an other example, Nicolas Oresme, in the *Questiones super Physicam*, claims that phenomena of the sublunary world are intrinsically contingent as they can be impeded from taking place by external constraints. According to Oresme, three kinds of contingency characterize sublunary world: "In a first way, there are phenomena that can be impeded because of their own nature, even if no man can impede them, as in a possible world a stone falls in a contingent way even if no man can impede it, because it can impeded by its own nature, even if no man its there [to impede the fall]. In a second way, [we say to be contingent] what in fact is and can be impeded, as for instance the fall of a stone towards the earth and the course of water, etc. Third, what is in fact impeded through free will, and thus is said to be by chance ['....est concedendum quod de facto in istis inferioribus multa eveniunt contingenter: quod potest intelligi tripliciter: primo modo, quod sunt impedibilia talia de natura sua, licet nullus homo posset impedire, sicut in terra inhabiltabili lapis cadit

The *contingentia ut plurimum* entailed some important theoretical consequences. Indeed, sublunary phenomena are at the same time necessary — in that they are determined by their form — and contingent — in that the actualization of their formal determination is intrinsically preventable. In the *Summa theologiae*, Aquinas deals with the question "*Whether the intellect can know contingent things, as understanding, doctrine and knowledge are not proper of contingent things, but only of necessary ones*." To this, Aquinas answers that

> …what is contingent can be considered in two ways. First, according to what contingent things are. Second, according to that which can be found in it that is necessary in itself. There is in fact no contingent thing that doesn't have in itself something necessary. […] Indeed, each thing is contingent because of the matter ["ex parte materia"], for contingent is what can or cannot be […]. Necessity on the contrary results from the form, because the things that follow from the form are necessarily present.[18]

A stone, to take the example of gravitation, possesses by necessity the form of heaviness. This form is its first act, since it is the principle by which every body tends *per se* to move downward towards the centre of the earth. However, the actualization of the form of being-at-the-centre-of-

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contingenter, quia de natura sua hoc posset impediri, si homo esset ibi. Secundo <modo>, quia est impediri et potest impediri, sicut descensus lapidum in terra habitabili vel cursus aquae etc. Tertio <modo>, quia de facto impeditur per liberum arbitrium, et tunc dicitur a fortuna. Et tunc dico aliqua. Primum est quod motus celi et que fiunt in superioribus nullo instorum modorum sunt contingentia, quia non sunt impedibilia. Secundo, dico quod quaecumque sunt inferius sunt contingentia primo modo, quia de natura sua <sunt impedibilia>. Tertio quod aliqua sunt contingentia secundo modo, et aliqua sunt etiam tertio modo.']" This brings Oresme to separate sharply sublunary from celestial spheres. The latter, as he writes, "are not contingent in any of these ways, because cannot be impeded." On the contrary, the former "are all characterized by the first way of being contingent, as can by their own nature being impeded. Others are contingent in the second way, and others even in the third (See Oresme 2013, 255-256)." This description of the contingency of the physical, sublunary world is still widely present in the seventeenth century, as it is testified, for instance, by the *Lexicon Philosophicum* of Goclenius ("Modi, quo Continges aliquid dicitur, tres sunt: Unus, quo dicitur quid evenire plerunque [sic] seu ut plurimum: Alter, quo pro re nata: Tertius, quo raro, ut fortuna. Primi Modi contingentia per se causas habent, & sunt epistemata, cum sint eorum rationes universales, ut necessariorum, quibus sunt vicina. Secundi et Tertii modi contingentia non habent causas necessarias, sed accidentalis. Itaq; non sunt epistemata. Horum (secundi & tertii modi) causae dicuntur indefinitae, quia effecta possunt efficere, vel non efficere, ita ut incerta sint. Ac Aliae sunt liberae, aliae fortuitae, & casuales. "There are three ways in which something is said to be contingent. First, of what is said to happen for the most part; second, according to circumstances; third, and more rarely, by chance. The contingent things of the first kind have per se causes, and are sciences, because their properties are universal as those of things said to happen by necessity, to which are similar. […]." See Goclenius 1613,169); and by the analogous work of Micraelius ("Contingens ut plurimum, est quod fit natura, cui quandoque ponitur impedimentum", "Contingent for the most part is what happens in nature, whenever an impediment is given." see Micraelius, 1653).

[18] "Respondeo dicendum quod contingentia dupliciter possunt considerari. Uno modo, secundum quod contingentia sunt. Alio modo, secundum quod in eis aliquid necessitatis invenitur, nihil enim est adeo contingens, quin in se aliquid necessarium habeat. Sicut hoc ipsum quod est Socratem currere, in se quidem contingens est; sed habitudo cursus ad motum est necessaria, necessarium enim est Socratem moveri, si currit. Est autem unumquodque contingens ex parte materiae, quia contingens est quod potest esse et non esse; potentia autem pertinet ad materiam. Necessitas autem consequitur rationem formae, quia ea quae consequuntur ad formam, ex necessitate insunt. Materia autem est individuationis principium, ratio autem universalis accipitur secundum abstractionem formae a materia particulari. Dictum autem est supra quod per se et directe intellectus est universalium; sensus autem singularium, quorum etiam indirecte quodammodo est intellectus, ut supra dictum est. Sic igitur contingentia, prout sunt contingentia, cognoscuntur directe quidem sensu, indirecte autem ab intellectu, rationes autem universales et necessariae contingentium cognoscuntur per intellectum. Unde si attendantur rationes universales scibilium, omnes scientiae sunt de necessariis. Si autem attendantur ipsae res, sic quaedam scientia est de necessariis, quaedam vero de contingentibus (I, q. 86, a. 3 arg. 1-2-3 and a. 3 co. See *Corpus Thomisticus*)."

earth can be impeded by the material constitution of the natural world, as well as by the material constitution of the thing itself. Therefore, a science of the natural world is possible if we consider the necessary, formal structure of things and their determination to act—regardless of the actualization of that determination. According to Aquinas, it follows that that the same thing can be understood as necessary by means of the intellect, and contingent by means of senses:

> Necessity results in reason of the form, as the things that result by form are necessary. Matter is the principle of individuation, and so the universal cause is reached by abstraction of the form from the particular matter. Previously it has been said that the intellect is per se and directly of universal things, whereas sense of the singular ones, of which intellect is indirectly, as we have said before. It follows that contingent things as such are known directly by means of sense, and indirectly by means of intellect. The universal and necessary causes are known by means of the intellect. (Ibid.)[19]

Physics, Aristotle thought, is certainly a science, though, not dealing with things that happened with absolute constancy but only "for the most part", it does not have the same stature as perfect disciplines such as astronomy or geometry. In the sublunary world, Aristotle thought, matter prevents forms from actualizing with absolute necessity. Chance — that is, individual instantiations of phenomena — is therefore an intrinsic characteristic of our world, and of chance there can be no science. Contingency, in this frame, was understood as ontologically intrinsic to natural events.

The rise of mechanical philosophy in the seventeenth century is generally thought to coincide with the decline of a vision of the natural world — the one vaguely comprised under the broad umbrella of "Aristotelian-Scholasticism" — that was underpinned by the understanding of contingency described above. As scholars have highlighted, however, the transition was not a simple switch, but rather a process. Still, roughly, by the end of the seventeenth century, inquirers were largely addressing problems and issues which had characterized scholastic physics and science, often using similar terminology, and ultimately offering solutions that were still connected with the theoretical framework that had characterized their education as well as represented the dominant intellectual background of the time. In a discipline such as mechanics, for instance, whereas early modern inquirers such as Galileo and Descartes worked their out solutions "by applying and modifying an independently grounded, pre-existing conceptual system," their followers "read the old problems and arguments from the point of view of their new solutions, thus establishing classical mechanics, because their point of departure was…the concepts as they [were] implicitly defined within the derivations of the theorems."[20]

[19] Latin in the note above.
[20] Damerow et al., (2011), 5, 3.

In this paper, I offer an example of the complexity of the passage to a new understanding of contingency. My case study is offered by Descartes' early draft of his physical system: *Le Monde, ou Traité de la lumière*. Written between 1629 and 1633, and likely abandoned following the flare-up of the Galileo affair, *Le Monde* was then published only in 1664 and, entirely, in 1677.[21] My contention is that, differently from the *Principles of Philosophy* (1644), this early draft of Descartes' system is still permeated by the understanding of contingency that characterized late-Scholastic physics. That is, in what was meant to become the first exposure of his new physics to the early-seventeenth-century intellectual world, Descartes still outlined the relation between the divine action of nature and the actual behaviour of physical bodies following at large the explanatory framework that characterized the late-Scholastic understanding of contingency. Though this position was eventually abandoned in the *Principles*, this case-study offers two main insights. First, it shows an example of Descartes' own process of adjustment to the theoretical consequences that the framework he had conceived implied vis-à-vis the understanding of the natural world. While elements of Scholasticism also characterized Descartes' later production,[22] this example is particularly interesting, I believe, for, as I shall show, it is in open conflict with the understanding of the necessity of the natural world which Descartes was unfolding, in private, to Mersenne. As a consequence, this shows an example of how the departure from the framework of scholastic physics was a process marked by strong theoretical challenges. Second, this case shows well how the rise of mechanism did not coincide *immediately* with a transformation of the understanding of contingency – that is, from an ontological problem to an epistemological one.[23] Significant elements of this schema, for instance, persist in Descartes' later explanation of curvilinear motion. Again, such a transformation is to be characterized as a process in which the actors themeselves reconceptualized their understanding natural irregularities in a new way, connecting it with their new physical, as well as metaphysical, tenets.

§2. Descartes' "Epistemological Contingency".

On April 15, 1630, Descartes wrote to Mersenne to expose some metaphysical features of the "physics" he was composing. "I will not omit to treat, in my *Physics*, of many metaphysical questions, and in particular this one: that the mathematical truths, which you name eternal, have been established by God and depend entirely on him, as do all the rest of the creatures." Indeed, Descartes continued, "it is in fact to speak about God as of a Jupiter or Saturn, and to subjugate him

[21]For details on the dating and history of *Le Monde*, see for instance Gaukroger (1995).
[22] On this, see for instance Ariew (2011).
[23]See the introduction to this volume.

to the Styx and to fate, to say that these truths are independent from him." God, Descartes continued, has established such eternal laws in the same way as a monarch establishes the laws of his country. But, differently from those set up by a monarch, these laws are eternal, for the will of God cannot change in the same fashion as the one of a king:

> You will be told that if God established these truths, he could change them as a King makes his laws; to which it is necessary to answer that, yes, if his will can change. – But I understand them as eternal and immutable. – And I, for my part, judge the same of God. – But his will is free. – Yes, but his power is ungraspable; and generally we can well assure that God can do all that we can understand, but not that he cannot do what we cannot understand; for it would be reckless to think that our imagination has as much extension as his power. (Descartes to Mersenne, XXI)[24]

Following a period of "metaphysical meditation" to which, he wrote, he had devoted the first weeks of his stay in Holland, Descartes reached a mature formulation of his understanding of mathematical laws that would characterize at large his philosophical and scientific production. Eternal laws are indeed created by God, but, depending on his will, and being his will immutable, they hold in fact eternal validity. For Descartes, this implies, among other things, the total knowability of these laws: while we cannot grasp God's greatness, "there is no [law] in particular that we cannot understand, if our spirit focuses on it, and they are all *mentibus nostris ingenitae*, in the same way as a King would impress his laws in the hearts of all his subjects, if he had the power to do so."[25] In the exchanges that follows this letter, Descartes equates the necessity of the eternal laws to that of all other creature in nature. As he wrote,

> You ask *in quo genere causae Deus disposiut aeternas veritates*. I answer you that it is i*n eodem genere causae* that he created all things, that is to say, *ut efficiens et totalis causa*. For it is certain that he is the Author of the essence as well as of the existence of creatures: or this essence is no other thing that those eternal truths, which I do not conceive at all to emanate from God like the rays of

[24] Descarte (1897), 145–46: 'Mais ie ne laifferay pas de toucher en ma Phyfique plusieurs questions metaphysiques, & particulieremant celle-cy : Que les vérités mathématiques, lesquelles vous nommés éternelles, ont elle establies de Dieu & en dépendent entieremant, aussy bien que tout le reste des créatures. C'eft en effait parler de Dieu comme d'vn Iuppiter ou Saturne, & l'assuiettir au Stix & aus destinees, que de dire que ces vérités font indépendantes de luy. Ne craignes point, ie vous prie, d'assurer & de publier par tout, que c'est Dieu qui a establi ces lois en la nature, ainsy qu'vn Roy establist des lois en son Royausme. Or il n'y en a aucune en particulier que nous ne puissions comprendre si nostre esprit se porte a la consyderer, & elles sont toutes mentibus nostris ingenitae, ainsy qu'vn Roy imprimeroit ses lois dans le coeur de tous ses sugets, s'il en auoit aussy bien le pouuoir. Au contraire nous ne pouuons comprendre la grandeur de Dieu, encore que nous la connoissions. Mais cela mesme que nous la iugeons incomprehensible nous la fait estimer dauantage ; ainsy qu'vn Roy a plus de maiesté lors qu'il est moins familieremant connu de ses sugets, pourueu toutefois qu'ils ne pensent pas pour cela estre sans Roy, & qu'ils le connoissent assés pour n'en point douter. On vous dira que si Dieu auoit establi ces vérités, il les pourroit changer comme vn Roy fait ses lois ; a quoy il faut respondre qu'ouy, si sa volonté peut changer. — Mais ie les comprens comme éternelles & immuables. — Et moy ie iuge le mesme de Dieu. — Mais sa volonté est libre. — Ouy, mais fa puissance est incomprehensible ; & generalemant nous pouuons bien assurer que Dieu peut faire tout ce que nous pouvons comprendre, mais non pas qu'il ne peust faire ce que nous ne pouvons pas comprendre ; car ce seroit témérité de penfer que noftre imagination a autant d'estendue que fa puissance'.

[25] Ibid., see note above.

> Sun; but I know that God is the author of all things, and that these truths are something, and therefore that he is their Author. (Descartes to Mersenne, XXII bis, 27 May 1630).[26]

God, Descartes wrote, is the efficient and total cause of both eternal truth and of the essence and existence of all things of nature, which means, in Scholastic terms, an efficient cause that "by its order and kind alone produces all the effect, as a horse that alone draws a cart".[27] Since God's will is immutable, it follows then that the order of nature follows necessarily and constantly his causative action.

Such belief in the necessity of God's causation underpins the metaphysical frame of Descartes' physics.[28] In the *Principles of Philosophy*, Descartes stated that motion has indeed two causes: a general one—the general cause of motion in the world—and what he described as a particular or secondary one—the production of a particular motion in a determinate portion of matter. The first, he claimed, is God:

> …as far as the first one is concerned, it seems clear to me that this is no other than God himself. In the beginning in his omnipotence he created matter, along with its motion and rest; and now, merely by his regular concurrence, he preserves the same amount of motion and rest in the material universe as he put there in the beginning. (II, 36)[29]

According to Descartes, it is the simplicity and constancy of God's action tht engenders the constancy of nature itself. To be sure, in order to remain constant with the Christian dogma, Descartes had to recognize that God can, potentially, always intervene, suspending the regular course of nature with his special providence. He therefore writes, "…there are some changes whose occurrence is guaranteed either by our plain experience or by divine revelation, and either our perception or our faith shows us that these take place without any change in the creator". But, let alone such circumstances, "we should not suppose that any other changes occur in God's works, in case this suggests some inconstancy in God." As a consequence, Descartes claimed,

> God imparted various motions to the parts of matter when he first created them, and he now preserves all this matter in the same way, and by the same process he originally created it; and it follows from what we have said that this fact alone makes it most reasonable to think that God likewise always preserves the same quantity of motion in matter. [30]

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[26] Ibid., 151-152.
[27] Eustachius (1626), 161: Total cause is said "…illa dicitur quae sola in suo ordine, and genere totum effectum producit, ut equus qui solus traheret currum."
[28] On this, see Garber (1992).
[29] Descartes (1985), 240.
[30] Ibid.

While the constancy of nature follows from God's ordinary concourse, the actual motion that each portion of matter makes in each moment of time derive, also, from the continuous collisions to which, in a plenum universe, they are unavoidably exposed. These (as Descartes called them) "secondary" or "particular" causes allow to derive a set of three laws of nature, stating, respectively, the tendency of things to persist in their state (both physical and kinetic, II, 37), to move rectilinearly (II, 39), and to engage in zero-sum kinetic collisions (II, 40). Descartes' description of final causation, however, appears not to allow for a substantial independence of created things to unfold their activity. While concurrentist Scholastic philosophers argued that the form of the thing made a "genuine causal contribution", along with God, to the unfolding of its effect, in Descartes' schema the causal contribution of individual things appears to be merely situational, as it appears to derive, mainly, from the complex net of kinetic relations that concur to determine, from one moment to the next, their physical state, while the source of their tendency to persist in their physical states is always provided by God.[31]

While this schema appears to leave no space to contingency – understood as an ontological feature of nature –, Descartes still had to deal with the presence of curvilinear motion in nature, as well as with the evidence that the motion of bodies of individual bodies does not remain constant but changes over time, starting from the (apparently) counterfactual claim that God's action is state-preserving. Famously, Descartes solves the first of these problems by describing curvilinear motion as a form of constrained rectilinar motion, and stating that, at each instant of time, the body exerts a "conatus", or endeavor, to move rectilinearly. In dealing with the second of these issues, it emerges that the action of God is not limited to the continuous conservation of states and motion: also the rules of collision do not follow directly from the essence of the bodies, but are preordained by the

[31] On concurrentism, see Freddoso (1994): 131-156, 134: "Concurrentism, which flourished among the late medieval Aristotelian scholastics and certain figures in the early modern period, occupies a middle ground between what its advocates perceive as the unseemly extremes of occasionalism and mere conservationism. According to concurrentism, a natural effect is produced immediately by *both* God *and* created substances, so that, contrary to occasionalism, secondary agents make a genuine causal contribution to the effect and in some sense determine its specific character by virtue of their own intrinsic properties, whereas, contrary to mere conservationism, they do so only if God cooperates with them contemporaneously as an immediate cause in a certain "general" way which goes beyond the conservation of the relevant agents, patients, and powers, and which renders the resulting effect the immediate effect of both God and the secondary causes. This cooperation with secondary causes is often called God's *general concurrence* or *general concourse*." Scholars have discussed whether individual things in Descartes system hold in fact any causal power. A negative answer to this question seems to result in approaching Descartes to occasionalism. This is the position held, for instance, by Garber (1993) and Hatfield (1979). Schmaltz (2008), on the contrary, argued for a genuine causal relation from body to body.

divine law. This allowed Descartes to reach the (apparently) paradoxical conclusion that the mutability of nature proves the immutability of God:

> For the whole of space is filled with bodies, and the motion of every single body is rectilinear in tendency; hence it is clear that when he created the world in the beginning God did not only impart various motions to different parts of the world, but also produced all the reciprocal impulses and transfers of motion between the parts. Thus, since God preserves the world by the selfsame action and in accordance with the selfsame laws as when he created it, the motion which he preserves is not something permanently fixed in given pieces of matter, but something which is mutually transferred when collisions occur. The very fact that creation is in a continual state of change is thus evidence of the immutability of God. (II, 42).[32]

In this frame, contingency acquires a prominent "epistemological" connotation. From II, 45 to 52, Descartes set out a set of seven "rules" with the aim of covering the possible interaction between rigid bodies. However, far from covering all possible scenarios, these rules are meant to apply, in fact, in an ideal (emtpy) space where all interactions but binary ones are in fact disregarded.[33] Having forcifully excluded the existence of vacuum in nature on the basis that it would amount to pure nothing (II, 15-18), and having equated matter and space, Descartes was aware that no collision can in fact be purely binary. As a consequence, the rules he provided are just an approximation of what actually takes place when hard bodies collide. An exact calculation of such interaction, therefore, appears ultimately to lie outside the power of human understanding:

> But since no bodies in the world can be divided in such way from the others, and no [body] around us is usually totally rigid, such calculation to determine how much the motion of each body is changed by the impact with another is thus much harder to be undertaken. At the same way, indeed, one must have a ratio of all the other [bodies] that it is in contact with, and which, in relation to it, have a variety of different effects, insofar as they are rigid or soft. (II, 53)[34]

§3. Descartes' Ambiguous Description of Nature in *Le Monde*. "Ontological Contingency"?

The understanding of contingency implied in this statement is surprisingly not to be found in *Le Monde*. Here, the description of the relation between divine action and nature appears to be rooted in a very different framework. This appears particularly clear when, in chapter 7, Descartes introduced the discourse on the laws of nature. He wrote:

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[32] Descartes (1985), 242.
[33] On this, see McLaughlin (2000).
[34] Descartes (1973), 70: "Sed quia nulla in mundo corpora esse possunt a reliquis omnibus ita divisa, & nulla circa nos esse solent plane dura, ideo multo difficilius iniri potest calculus, ad determinandum quantum cujiusque corporis motus ob aliorum occursum mutetur. Simul enim habenda est ratio eorum omnium, quae illud circumquaque contingunt, eaque, quantum ad hoc, valde diversos habent effectus, prout sund dura vel fluida […] ".

> Know, then, first that 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. For 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."[35]

Here, Descartes' position appears closer to that of a conservationist that to that of a concurrentist.[36] God conserves, through his concourse, natural substances, which seem however to be described as "genuine agents," capable of engendering genuine effects. The "laws of nature" are attributed, in other words, not only to the conservative, immutable action of God, but also to the changeable state of matter, which appears somehow to resist his action. Matter, as in the Scholastic framework described above, is identified with the element of such changeability, providing an impediment to the implementation of God's conservative action. As a consequence, the preservation of created substances does not correspond with the indefinite preservation of their states, which, on the contrary, are described to change "comme par accident", "as by accident":

> To understand this better, recall that, among the qualities of matter, we have supposed that its parts have had diverse motions since the beginning when they were created, and furthermore that they all touch one another on all sides, without there being any void in between. Whence it follows of necessity that from then on, in beginning to move, they also began to change and diversify their motions by colliding with one another. Thus, if God preserves them thereafter in the same way that He created them, He does not preserve them in the same state. That is to say, with God always acting in the same way and consequently always producing the same effect in substance, there occur, *as by accident*, many diversities in that effect.[37]

The treatment of curvilinear motion in *Le Monde* also proceeds along these lines. Similarly to what he would do in the *Principles* (though in *Le Monde* he identified it with the third of the laws of nature), Descartes described curvilinear motion as a constrained reclinear one. The proof of this, according to him, is provided by the fact that a stone revolving around a sling, if released, would continue its path along a tangent, and not along the circle described by its rotation. As the argument goes on, however, Descartes compared curvilinear motion to a locus classicus of the medieval understanding of contingency, that is, to the possibility of sinning. As he wrote,

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[35]Descartes (1978), 59.

[36] Freddoso (1994): 133–34: "According to mere conservationism, God contributes to the ordinary course of nature solely by creating and conserving natural substances along with their active and passive causal powers or capacities. For their own part, created substances are genuine agents that can and do causally contribute to natural effects by themselves, given only that God preserves them and their powers in existence. When such substances directly produce an effect via *transeunt* action (i.e., action that has an effect outside the agent itself), they alone are the immediate causes of that effect, whereas God is merely an indirect or remote cause of the effect by virtue of His conserving action. Consequently, the actions of created substances are their own actions and not God's actions, and their effects are their own immediate effects and not God's immediate effects."

[37] Descartes (1978), 59–61. Emphasis added.

> According to this rule, then, one must say that God alone is the author of all the motions in the world, insofar as they exist and insofar as they are straight, but that it is the diverse dispositions of matter that render the motions irregular and curved. So 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 that it is the diverse dispositions of our wills that can render those actions evil.[38]

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, rather, is to maintain their rectilinear motion, which instead derives directly from the action of God on nature. Curvilinear or circular motion is therefore a *mediate consequenc*e 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. 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. The immanent action of God on nature is responsible exclusively for rectilinear motion, whereas curvilinear motion derives from the impediments that this action unavoidably encounters in the material world. In *Le Monde* (as later in the *Principles*), Descartes does not appeal to forms in order to explain the kinetic behavior of bodies. Still, he appeals to a necessary element — the action of God — to explain the behavior of bodies absent external impediments. From the point of view of *causation*, this action is absolutely necessary. However, the *actualization* of this continuous action of God is in fact contingent: in real world-experience, rectlinear motion does not happen but rarely and for limited time. This is because the very constitution of the material world impedes bodies from moving rectilinearly and indefinitely as the action of God would urge them to do.

§4. Conclusion.

It does not appear to be far-fatched to compare Descartes' understanding of circular motion in *Le Monde* to the late-Scholastic idea of *contingentia ut plurimum*. In both cases the lack of a complete actualization of motive tendencies (which in the one case derive from the form of the object, and in the second from the action of God) depends on the action of matter. The result is that, in *Le Monde*, despite the emphasis Descartes put on the presence of immutable laws, nature as such complicates, by its own property, the divine design. While in the *Principles* the mutability of nature is adduced as a proof of the constancy of the divine action, earlier it was presented as a result of the impediments that such action encounters. The result is that matter is presented as an element of

[38] Ibid., 75.

intrinsic contigency that limits our full understanding of nature: not in virtue of its complexity—as in the *Principles*—but because of power of producing effects "as by accident". As in Scholasticis, we therefore have to turn to the necessary element of the activity of natural things—God's constant action of conservation—to make sense of otherwise ephemeral and changeable natural phenomena. In a similar vein, few years before, in a letter to dal Monte, Galileo had claimed that "…*quando cominciamo a concernere la materia, per la sua contingenza si cominciano ad alterare le proposizioni in astratto dal geometra considerate*."[39]

While the idea of contingency that emerges in *Le Monde* appears to be still influenced by that characterizing Scholastic tradition, in the *Principles* Descartes overcame such ambiguities, adapting his understanding of contingency to the metaphysical and theoretical premises that he himself had expounded to Mersenne in 1630. However, though here Descartes identified it with our difficulties in penetrating the complexity of nature, elements of his previous understanding of contingency appear to remain, as a sort of "Zeitschicht,"[40] in his treatment of circular motion. Late-Scholastic natural philosophers often appointed the force exerted by an object when prevented from moving towards the centre of its sphere as a *conatus* – as seen, a fundamental concept of Descartes' account of circular motion.[41] If I held a falling stone, for instance, it would exert a certain force to move downwards, which late-Scholastic natural philosophers described as a "conatus." Similarly, a stone thrust upwards would exert a conatus to move downwards, which would eventually exhaust the impetus received.[42] In late-Scholasticism, conatus was therefore a key-term to explain what happens

[39] Galileo, Letter to Ubaldo dal Monte, 29 November 1602, in Galileo (1842), 242: "…when we start to consider matter, the proportions considered in the abstract by geometry begin to alter due to its contingency."
[40] See Koselleck (2002).
[41] See my Garau (2014): 479–94; see also Leijenhorst (2006).
[42] See for instance . Collegium Conimbricenses (1602) "…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 (Libri v Caput VI, *Explanatio.*) '[...] 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 (Libri v Caput VI, *Explanatio*)', 202; Eustachius a Sancto Paulo (1620), III, 121: "…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 (Libri v Caput VI, *Explanatio.*) ""Corpora gravia supra levia, aut graviora supra minus gravia ubicunque sint gravitant: similiter levia infra gravia, aut leviora inf. minus levia levitant. Cujus assertionis veritas experientia constat: ubicunq. enim gravia ponuntur, cofestim 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'; Fabri, (1646), 417: "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 […]. (Book X.)" ""Reſp. 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

to a body in a state of contingency – that is, when its natural motion is impeded. In its transition from its original hylomorphistic background to the Cartesian, mechanistic physics, *conatus* preserves the connotation of force exerted when the intrinsic motive tendency of bodies is impeded. This applies in particular to Descartes' explanation of circular motion as a constrained rectilinear one, which has a fundamental role in its description of the nature of light. In *Principles* III, 57 the circular motion of a body is presented as the result of the combination of different rectilinear, kinetic components. As Descartes puts it, "Since frequently many different causes act at the same time on the same body, and one impedes the effects of the others, as far as we pay attention to these or those [causes], we can say that this [body] tends or strives to move ["ire conari"] at the same time in different directions. In fact, were it not to be impeded by the sling, the stone would move away tangentially from the circle it describes, since "the sling can prevent this effect, but not the striving ['conatus']."[43]

It is easy to understand why this concept would have had slight importance in the late-Scholastic framework, as opposed to its fundamental significance for Descartes: in the Aristotelian world, the regularity of natural phenomena reflected the natural behavior of bodies. The regular course of the sublunary world entailed that stones fall down along a straight line towards the centre of the earth, that is, acting according to the movement necessitated by their forms. Deviations from regularity were a violent displacement or hindrance of the body from the actualization of its intrinsic kinetic determination. Although the possibility of violent displacement and hindrance of natural motion is intrinsically possible in the sublunary world (and this is the reason why it is described as contingent), this constitutes the unpredictable exception to an otherwise full regularity of the course of events. *Conatus* takes on new conceptual relevance in merely hypothetical frameworks, or, later on, when the development of the technology of ballistics and of the first efforts to explain the motion of projectiles theoretically also urged Scholastic natural philosophers to wrestle more profoundly with the multifaceted aspects violent motion.[44] On the contrary, in Descartes's universe almost all intrinsic motions seem to be hindered. The regularity of natural phenomena does not stem from the motion that God imparts to bodies, but from the fact that this hindered motion still initiates a tendency to move and a force. In this universe, where all distinctions between the celestial and sublunary world are abolished, nothing results that is more regular than the course of the heavens. However, this regularity stems from the mutual hindrance of intrinsic motive determination that the

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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, ita & impotetus organi motricis, nec eſt magna difficultas; immò clariſſima vtriuſque potentiæ analogia."

43 "…funda hunc effectum impediat, non tamen impedit conatum (AT VIII-1, 109)."

44 For an account of the relations between the practice and the theory of ballistics, see for instance Valleriani (2010 abd 2013).

corpuscles composing them initiate, and, at the same time, by the tendencies and forces (*conatus*) which thereby result. Circular motion in this way can be explained as a by-product of rectilinear inertia. *Conatus*, therefore, becomes essential to the explanation of the physical behaviour of bodies.

In his ambiguous treatment of the topic in *Le Monde*, and then his more settled one in the *Principles*, Descartes can be then seen as embodying the transformation of contingency—from an ontological question to an epistemological one—which Pietro Omodeo and I have highlighted in the introduction to this volume.

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