doispontos:
Revista dos Departamentos de Filosofia da Universidade Federal do Paraná e da Universidade Federal de São Carlos

Considerations on inertia, causality and temporality in Descartes[1]

Gerson Luiz Louzado
gllouzado@gmail.com
Federal University of Rio Grande do Sul – UFRGS

Abstract: In this paper we tried to examine the grounds of the cartesian thesis of the continued creation as wellas the conception of time that it implies. On the one hand the necessity to take time as metaphysically discrete and as physically continuous from the analysis of the connections between inertia, causality and temporality were examined. On the other hand, we sought to explain the possibility of such a conception by analyzing the main Cartesian theses about time.
Keywords: Descartes; metaphysics; physics; inertia; causality; time.

[1] I thank Lia Levy for her criticism, suggestions, and comments. I also thank the participants of the seminar on substance and causality in modern philosophy for their comments.

Descartes, as it is well known, was one of the first, if not the first, to expressly formulate the principle of inertia.[2] In the *Principles of Philosophy*, in the context of the metaphysical foundation of physics, the principle is expounded in the first and second laws of nature. In the first law, Descartes maintains that each thing, while it is, always perseveres in the same state. Later on, in the elucidation of the law, he adds: "each thing, while it is simple and undivided, remains, while it is in itself, in the same state, which must not be altered, unless prevented by external causes" (DESCARTES, 1905, part II, art. 37, p. 62). In the formulation of the second law, he maintains that motion, of itself, is rectilinear, which is why bodies in circular motions always tend to move away from the center of the circle they describe (*Id.*, *ibid*., part II, art. 39, p. 63). The combination of these two laws allows the formulation of the principle of inertia in terms of a *tendency* (a *conatus ad motum*)[3] of bodies to maintain their states of rest or uniform rectilinear motion if they are not led to change these states by the intervention of external causes.

Strictly speaking, as can be noted from the formulation of the first law, the proper exposition of the conjunction of the two laws of nature should carry a positive thesis and a triple qualification to the validity of the same, qualification exposed in the restrictive adjectival subordinatives, "while it is simple and undivided" and "while it is in itself", and in the conditional adverbial subordinative, "unless hindered by external causes". Thus, the *conatus* or tendency expounded in the principle of inertia would require to be formulated roughly in the following terms: each thing, while it is simple and undivided, remains, while it is itself, always in the same state of rest or uniform rectilinear motion, unless hindered by external causes. However, it can be observed that, on the one hand, the first qualification, "while it is simple and undivided," is much more properly concerned, as will be seen below, with the presentation of a paradigm of a physical event in the form of the shock. On the other hand, the second of these restrictions, "while it is itself", seems to be nothing more than a reduplication, of merely stylistic effect (of emphasis), of the condition introduced by the adverbial subordinate, "unless prevented by external causes". In view of this, a thing, while it is in itself, is a thing in its present state independently of the intervention of external causes.[4] [4] Put in these terms, the principle of inertia could, without loss, be formulated by appealing to the positive thesis, "everything always remains in the same state of rest or of uniform rectilinear motion," and to a single qualification or restriction on its validity, a qualification which precisely makes the principle of inertia the expression of a *tendency* and not of an invariable necessity: "unless hindered by external causes.

[2] As Alexandre Koyré observes, "the most beautiful title of glory of the Descartes-physicist is, without doubt, that of having given a 'clear and distinct' formula for the principle of inertia and having put it in its place" (KOYRÉ, 1966, p. 161). In another work by Koyré we find: "the term inertia comes from Kepler, in whom, however, it means resistance to movement, *inclinatio ad quietem*. The concept of inertia = indifference of the body to *rest and movement*, persistence of the body in its two states comes from Descartes who, however, rejects the Keplerian term; Newton retains it by modifying the meaning" (KOYRÉ, 1973a, p. 211, note). Although Galileo did not exactly formulate the principle of inertia, in particular because he did not admit a physical body without gravity and because he considered natural motion to be circular (BLAY, 1993, p. 46), it plays an essential role in his theory of motion. One can find, for example, in the second day of the *Dialogue on the two maximum Ptolemaic and Copernican world systems* of 1632 (GALILEO, 2004, pp. 228-229), the presentation of the assumptions for the formulation of that principle.

[3] Expression used in article 56 of the third part of the *Principia philosophiae* (DESCARTES, 1905, p. 108): "how to understand the conatus *ad motum* in inanimate things". In this article, Descartes points out, dealing with a case of application of the second law of nature, that the tendency of the globules to move away from the center of the circle they describe is not to be understood as involving any act of thought (or, one could say, of intentionality or will), but is related only to the position and the way they are impelled to maintain a uniform rectilinear direction tangential to the circle (see also articles 57-60, pp. 108-112).

[4] This is also Spinoza's interpretation in the demonstration of proposition 14, part II, of the *Principles of Cartesian philosophy* (ESPINOSA, 2015, pp. 149-151). Similar interpretation is followed by Michael Della Rocca (DELLA ROCCA, 1996), who uses the Cartesian notion of tendency, as expounded in the principle of inertia, for the interpretation of the Spinosian notion of conatus occurring in proposition 6 of the third part of the Ethics.

doispontos:, Curitiba, São Carlos, volume 16, issue 3, December 2019, pages 1-14
DOI: https://doi.org/10.5380/dp.v16i3.66669t

This principle, which is at the very "heart" of the modern scientific revolution by constituting the most fundamental law of the new physics,[5] supposes the thesis that there are no intrinsic differences between movement and rest - thesis, in turn, founded on the consideration of all movement as being relative (DESCARTES, 1905, part II, art. 24, p. 53). In the qualitative and finalist physics of Aristotelian extraction, movement was seen as the phenomenon to be explained,[6] since rest, taken as the body's natural state (determined, in part, by its nature), was understood as the end of the movement process by which the body reaches its *natural place*.[7] Thus, as the determining cause of natural movement, as the principle of causal explanation in the quality of final cause, it did not demand a causal explanation. In the new physics, to consider motion as being relative, as being determined exclusively by extrinsic and relational factors, implies precisely the supposition that there is no fundamental principle for the distinguishability of rest and motion, allowing both to be taken as states of bodies and, therefore, as not being changes in bodies. That motion is no longer considered as change implies, in turn, that it, as well as rest, no longer demands causal explanation. The change of the status of motion from *process* to *state* can, in view of this, be considered as responsible for a change in the object of physics, a revolution, if you prefer: it is no longer a question of explaining the motion, but rather the change of the motion. If, then, the inertia principle contributes to the definition of a new object for physics in such a way that the change of motion is taken as a physical phenomenon par excellence, it contributes, for the same reasons, to the redefinition of the place of physical causality and, in this way, to the redefinition of what can count as a cause: a cause is that which, by external intervention, changes the motion (or rest) of a body (as opposed to that which determines motion in physics with Aristotelian roots).

[5] "(...) the principle of inertia occupies an eminent place in classical mechanics in contrast to that of the ancients. It is the fundamental law of motion; it reigns implicitly over the physics of Galileo, explicitly over that of Descartes and Newton" (KOYRÉ, 1973b, p. 169).

[6] In ancient physics, local motion was taken as a particular case of change, distinguishing two types of local motion: natural motion, by which a body would strive to reach its natural place, and violent motion, which would be the effect of some force capable of preventing the natural motion. Both types of movement constituted the change to be explained, and were therefore definers of the physical phenomenon itself (KOYRÉ, 1973b, pp. 175-177).

[7] The Aristotelian doctrine of motion and its relation to natural place is succinctly presented by Maurice Clavelin in the following terms: "it is unquestionably on the ordered structure of the cosmos and the simple upward and downward motions that Aristotle based his distinction between natural motion and violent motion, and between motion and rest in general. Cosmology provides an *a priori location* of *natural places* between and toward which bodies can move; it also implies that everybody has an intrinsic principle of upward and downward motion. From this it follows that a body having the quality of lightness and being propelled upward or a body having the quality of heaviness and being propelled downward will perform movements in harmony with the order of things, that is, their respective movements would be natural; conversely, a body having the quality of lightness now propelled downward or a heavy body moving upward will be describing unnatural or violent movements. Therefore, there is no justification for attributing, as is sometimes done, the natural or violent nature of their movements exclusively to the nature of the bodies; lightness and heaviness being qualitatively distinct principles and not merely consequences of the quantity of matter involved, the origin of the opposition between natural and violent movements must be sought among the a priori principles governing the organization of the cosmos. By treating them as such, Aristotle was, in effect, introducing an essential distinction between motion and rest. The transition from the idea of natural motion to that of natural rest is simple: if light bodies tend to move upward and heavy bodies tend to move downward, then a light body having reached the end of its ascent or a heavy body having reached the end of its descent will have reached a state of natural rest. What do we mean when we say that a body has reached a state of natural rest? Only this: that it will offer active resistance to any attempt to move it. It is, of course, difficult to imagine the nature of Aristotelian resistance because, unlike the inertia of classical mechanics, it cannot be reduced to the simple tendency of a body to persist in its present state; according to Aristotle, the resistance shown by the body has its true origins in the fact that its form can be actualized only in its natural place, and it is thanks to this actualization that it will always show the same resistance to motion that nature shows to anything that tries to disturb its order. Therefore, motion and rest can never have the same ontological meaning for material bodies; insofar as 'motion toward its proper place is, for everything, motion toward its proper form,' motion remains the normal means by which the essence of things can achieve its full expression. Natural rest, on the other hand, because it is an actual rather than a potential state, must necessarily enjoy priority over motion. It is this point, perhaps, that reveals more than any other the extent to which the Aristotelian theory of local motion depends on its cosmological premises, and also the extent to which the construction of classical mechanics was dependent on the demolition of that cosmology" (CLAVELIN, 1974, pp. 20-21). A synopsis of Aristotelian theory of motion can also be found in DIJKSTERHUIS, 1986, pp. 17-42).

In the *Principles of Philosophy*, after the introduction of the principle of inertia through the first and second laws of nature, Descartes presents a third law, which is the foundation of the laws of shock:[8] "when a body encounters a stronger one, it loses nothing of its motion; when it encounters a weaker one, it loses as much as it transfers" (DESCARTES, 1905, part II, art. 40, p. 65). One can consider that this third law is responsible, on the one hand, for introducing shock as a model for physical or natural causality. On the other hand, by establishing as fundamental the shock between bodies which, being simple and indivisible (according to the formulation of the first law), are (mechanically) perfectly hard,[9] defines in terms of this hardness, as an absolute exteriority, the exteriority of the causes required by the formulation of the inertia principle. Thus, the standard model of the collision between bodies is constructed and, therefore, the paradigmatic type of natural causality and of the physical event itself.[10]

It should be noted, however, that, according to Descartes, the set of laws of nature is ultimately completely dependent on God who, unchanging, preserves material bodies in their states (rest or motion and direction of motion). God, it is worth emphasizing, preserves them not as they might have been moments before, but as they must be (or in the position they must be in) at the precise moment they are preserved (DESCARTES, 1905, part II, art. 39, pp. 63-64). In the *third Meditation*, similar conservation is presented in the following terms:

> Indeed, it is a very clear and evident thing (for all who carefully consider the nature of time) that a substance, to be conserved at all moments of its duration, needs the same power and the same action that would be necessary to produce and create it again, if it did not exist yet. So that natural light shows us clearly that conservation and creation do not differ except with respect to our way of thinking, and not in effect (Descartes, 1988a, p. 42).

Now, if, as is also established in Axiom II *of the geometrical Exposition* (DESCARTES, 1988b, p. 104), "no less cause is necessary to conserve a thing than to produce it for the first time," one can take the continued conservation of the states of bodies as a continued creation, definable, therefore, in terms of causality.[11]11

[8] The laws of shock are presented in articles 46-52 of the second part of the *Principles*.

[9] See the subsequent article of the *Principles* (article 41), where Descartes presents the proof of the first part of the third law.

[10] The conservation of the total motion of the universe, envisaged in article 36 (DESCARTES, 1905, part II, p. 61), seems to depend on nothing of the motion being lost in the interiority of bodies. In the case of collision with flexible or elastic bodies, the motion of one body would be communicated, in whole or in part, to the parts of the body that suffered the collision, and so on (DESCARTES, 1973, p. 191, note 4 and p. 196, note 2).

[11] In other words: one can and, perhaps, should understand conservation in terms of creation, and not, as is often the case, understand creation in terms of conservation. In general, such an inversion passes through the appeal to the distinction between *causa secundum fieri* and *causa secundum esse* presented by Descartes in response to *Gassendi's Fifth Objections*: "When you deny that we have need of the concourse and continuous influence of the first cause in order to be preserved, you deny something which all metaphysicians affirm as very manifest, but which unlettered people do not often think of, because they direct their thoughts only to the causes which are called in the School *secundum fieri*, that is, on which effects depend as to their production, and not on those which are called *secundum esse*, that is, on which effects depend as to their subsistence and their continuance in being. Thus, the architect is the cause of the house, and the father the cause of his son, as to production alone; this is why, once the work is finished, it can subsist and remain without this cause; but the sun is the cause of the light that proceeds from it, and God is the cause of all created things, not only as to what depends on their production, but even as to their conservation or duration in being. This is why he must always act on his effect in the same way in order to preserve it in the first being that gave it. And this is shown very clearly by what I have explained concerning the independence of the parts of time, and which you seek in vain to elude by proposing the necessity of the sequence that exists between the parts of time considered in the abstract, concerning which you do not argue here, but only concerning the time or duration of the thing itself, of which you cannot deny that all the moments cannot be separated from those that immediately follow them, that is, that it cannot cease to be at each moment of its duration" (DESCARTES, 1988b, pp. 122-123). The appeal to the model of causality *secundum esse* to justify the treatment of time as continuous (see, for example, GARBER, 2001, pp. 195 ff.), however, it seems to depend, as Richard Arthur observes (ARTHUR, 1988, p. 358-360), on the compatibilization between the indivisibility of the divine act of creation and the infinite divisibility of the continuous duration of such act (supposing that the model of *secundum esse* causality requires that creation be continuous and, therefore, occur in a continuous time). In order to get around this difficulty, which was raised by Gueroult (GUEROULT, 1968, p. 274-275), Arthur resorts to the distinction between the nature and the duration of the act, a distinction presented by Descartes in correspondence with Burman on April 16, 1648, about a similar problem concerning the indivisibility of thought from which

doispontos:, Curitiba, São Carlos, volume 16, issue 3, December 2019, pages 1-14
DOI: https://doi.org/10.5380/dp.v16i3.66669t

In this case, however, since creation is the result of a voluntary act of God, we have the introduction of a causal regime different from the one in force in the physical world. Considering, then, the model of natural causality adopted by Descartes, the dynamic principle of the physical system (responsible, due to its strength, for providing the physical bodies with a state of initial movement) must necessarily transcend this system (and, obviously, it cannot itself be subject to the shock). In the Cartesian natural world system, therefore, there is a single dynamic principle (Descartes, 1905, Part II, Art. 36, pp. 61-62), God, who operates in a causal regime distinct from that in which nature operates. Here, the well-known Cartesian dualism is expressed precisely in this causal duplicity: the efficient natural causality, understood as a mechanical production mode of things according to the shock model, and the free divine causality.[12]

If, as indicated, the laws of nature find in the continued creation their metaphysical foundation, it is particularly necessary to consider the Cartesian reasons to support such thesis. In Axiom II *of the geometrical Exposition* (Descartes, 1988b, p. 104), the thesis of continued creation is founded on the independence of the parts of time: "the present time does not depend on the one that immediately preceded it; that is why no less cause is needed to preserve a thing than to produce it for the first time". At first sight, it seems reasonable to suppose that the independence of the parts of time is correlated to the assumption of the discontinuity of time itself: being it discrete, the parts (the moments or instants) would be first and independent in relation to the whole of time (which, as a *totum syntheticum*, could only consist of an integralization or relative totalization of instants already given) and extrinsic (or existentially independent) in relation to each other. If it were like this, we would have, therefore, the discontinuity of time implying the causal isolation of its moments, that is, implying that what happens in one instant of time does not causally determine what happens in another. However, in the *third Meditation*, Descartes seems to assume jointly the infinite divisibility of time (a divisibility that supposes its continuous nature) and the independence of moments, which, in turn, implies the causal isolation of moments and, through this, the continuous creation.

> And though I may suppose that perhaps I have always been as I am now, yet I could not avoid the force of this reasoning, and I do not fail to know that it is necessary for God to be the author of my existence. For all the time

one intends to infer its instantaneity (DESCARTES, 1991, pp. 334-335): "Thought will indeed be extensive and divisible with respect to its duration, since its duration can be divided into parts. But it is not extensive and divisible with respect to its nature, since its nature remains inextensive. It is exactly the same with God: we can divide his duration into an infinite number of parts, although God himself is therefore not divisible. Now, if, as will be shown later, the distinction between the nature of the thing (the thing itself) and its duration corresponds to the distinction imposed by articles 55 to 57 of Part I of the Principles between time and/or existence in the thing (time and/or existence substantively or metaphysically considered, which are indiscernible from the thing itself and its nature) and time and/or existence in the thing (duration and/or existence adjectively considered), and if in turn, the distinction between substantive or *materialiter spectatum* time and adjective or *formaliter spectatum* time implies treating the former as discrete and the latter as continuous, then there is no plausible recourse to causality *secundum esse* that does not ultimately entail treating it metaphysically as discrete.

[12] Additionally, one can observe that, since, hypothetically, God's designs in creating and sustaining the world are the designs of the world itself, the thesis of continued creation, by requiring the duplicity of the causal regime (the mechanical and the finalist), entails that the world has ends. Descartes, however, vetoes, due to the inability of finite beings to understand the divine infinitude and, therefore, to apprehend divine designs, the consideration of final causes of the world in the production of knowledge: "the final causes of created things must be examined, not the final causes, but the efficient causes" (Descartes, 2002, art. 28, p. 47). Such a veto, in turn, clearly opens a fissure between the order of knowledge of things, restricted to efficient causes mechanically considered, and the order of things themselves which, in spite of everything, seems to admit final causality. Although the admission of a finalist divine causality may be, by virtue of the indifference of divine freedom, a controversial issue in interpretation, it is worth remembering that, besides the fact that finalism consists of one of the unavoidable categories of analysis of voluntary causality, in the Principles of Philosophy, the veto to final causes presented in article 28 of part I makes an express appeal to the arrogance that would suit us if we thought we were "participants of their [God's and nature's] designs" (DESCARTES, 2002, art. 28, p. 47). Article 28, therefore, presupposes the existence of God, God's finalistic causal relations with created things, and the relation that the finite human intellect maintains with God's infinite nature: we are unable to penetrate the divine designs because God is infinite and our understanding is finite (cf. articles 19, 24, and 27). Note also that the same point is taken up in the opening articles of Part III of the *Principles* (DESCARTES, 1905, pp. 80-81).

> of my life can be divided into an infinity of parts, each of which does not depend in any way on the others; and so, from the fact that I have been a little before it does not follow that I must be at present, unless at this moment something produces and creates me, as it were, anew, that is, conserves me (DESCARTES, 1988a, p. 42).

This passage, not by chance, counts as one of the main textual foundations for interpretations that intend to refuse the identification of the parts of time with instants.[13] In such a circumstance, one would suppose that the "parts of time" to which Descartes refers can be understood as temporal segments existentially independent in relation to each other (BEYSSADE, 1979, pp. 129-142 and SECADA, 1990, pp. 52-62). However, it should be noted, first of all, that if the independence of the parts of time is the foundation of the principle of continued creation and if continued creation is, in turn, the metaphysical foundation of the fundamental laws of nature (namely, the principle of inertia and the principle of transference of motion by shock), then, by the very instantaneity of the communication of motion between the paradigmatic "perfectly simple and undivided" (and, for that reason, perfectly hard) things, continued creation must take place instantaneously. Moreover, from the principle of inertia, as indicated above, the *change of motion* is defined as the object of investigation of the new physics (as opposed to *motion as change* to be explained by Aristotelian physics). More than that, according to the exposition of the second law of nature, the uniform rectilinear motion is now considered as the fundamental natural motion, so that the circular motion gains the status of compound motion (from the rectilinear tangential motion to the circle described by the object and the centripetal motion). Thus, the *change of motion* that is constitutive of circular motion is point-to-point, instant-to-instant. According to the thesis of continuous creation, although the motion is not exactly instantaneous, its change is, and God (as the only dynamic principle of the world system) must, because of the instantaneous change in the direction of the motion, at every instant recreate the circularly moved object as it must be at this instant and not as it was at the previous instant. In that case, precisely because the independence of the parts of time is intrinsically connected to the continued creation and because creation is instantaneously continued only a correlative independence between the parts of time could be admissible. So, even if in the Latin edition of the *Principles* (in article 39, part II, concerning the second part of the inertia principle: preservation of the rectilinear direction of motion), the instantaneity of the continued creation is perhaps not sufficiently clear in function of the primordial appeal to the *moment* rather than the *instant*,[14] in the French edition endorsed by Descartes, this is not the case:

> This rule, like the preceding one, depends on God being immutable and on his preserving the motion of matter by a very simple operation, *because he does not preserve it as it may have been at some previous time, but as it is at precisely the same instant in which he preserves it*. And *although it is true that motion does not take place in an instant,* it is nevertheless evident that everybody that moves is determined to move along a straight line and not following

[13] If it is plausible to characterize in general the interpretations of the Cartesian conception of time as continuous in terms of an inversion of order that takes conservation as the model of creation and not the other way around, then on some of the difficulties underlying a strictly observable continuistic conception, see note 11. It is worth noting that, for some of the reasons outlined in note 11, in particular that the distinction between time and/or existence in the thing and time and/or existence of the thing imply, respectively, a discrete and a continuous treatment of time, it is impossible to claim an approach to the independence of the parts of time that is indifferent to the treatment given to time, whether continuous or discrete (as found in SECADA, 1990).

[14] "Causa hujus regulae eadem est quae praecedentis, nempe immutabilitas & simplicitas operationis, per quam Deus motum in matéria conservat. Neque enim illum conservat, nisi praecise qualis est eo ipso temporis momento quo conservat, nulla habita ratione ejus qui forte fuit paulo ante" (DESCARTES, 1905, pp. 63-64). According to Beyssade, translators of the Cartesian work would be less rigorous than desirable with Descartes' expressed distinction between momentum and instans (BEYSSADE, 1979, p. 135, note 4). Indicative of this would be, for example, the version of "brevissimo tempore, ac tanquam in momento" in article 111, part III of the *Principles*, simply for "presque dans um instant" in Fr. Picot's translation. It is not perfectly clear, however, that, in the expression "very short time, and as [if] in [an] instant", one should understand moment as a very short time or, rather, as instant - an alternative that would seem more reasonable in a comparison between the minute greatness of the time in question and the very deprivation of the greatness of the moment/instant to which it approaches. In any case, it seems beyond any doubt that, in the second law of nature (article 39 of Part II of the Principles), the Latin expression used, moment, must be understood as instant, just as the French version does. About the instant as limit and privation, see DESCARTES, 1963, p. 147 and DESCARTES, 1905, part III, art. 63, p. 115.

> a circular one, because when the stone *A* rotates in the sling *EA* following the circle *ABF*, *at the instant it is at point A*, it is determined to move somewhere... (DESCARTES, 1973, pp. 189-190, emphasis added).[15]

Admitting, then, that the continued creation is instantaneously continued and, therefore, that the instants of time are independent among themselves, one must, in the second place, consider that, to be valid the laws of nature, time, in the physical order, must, in its turn, be continuous: if "movement is not made in an instant", the continuity of the movement supposes the continuity of the time of the movement. Therefore, it would be appropriate to take it as discontinuous only *in a metaphysical order*.[16] Correlatively, if we must, as will be seen later, consider that the moments (the instants) of time are originally or metaphysically indiscernible from the existence and from the existent thing itself, then, to suppose that the "parts of time" to which Descartes refers can be understood as temporal segments (therefore as *tota continua*) existentially independent one in relation to the other, implies that, mixing the metaphysical and physical orders of consideration of time, a multiplicity of heterogeneous *quanta continua* is admitted, which, by continua, could only happen in the physical order. However, the mere aggregation of such unrelated physical variegatedness of temporal *quanta* continua would correspond, in the last analysis, to the dissolution of the causal unity of the physical world itself into temporal phases of things and, therefore, to the individuation of the furniture of the world according to temporal phases (where the phases of an object in time would constitute, in fact, different objects) and to the abolition of the principle of inertia and the laws of shock. Thus, to claim that different temporal *quanta* can be conjugated (by mere aggregation) into a single temporal *quantum* would be to claim that, in physical order, numerically distinct things (different phases of objects in time) are numerically identical (are one and the same object).

The difficulties exposed above are, in a way, mere variants of those raised in the debate about the genesis and composition of the continuum that mobilized philosophers and mathematicians throughout the 17th and 18th centuries. Such debate can, and perhaps should, be considered as an expression of a progressive shift in the project of building a mathematical physics (BLAY, 1993, pp. 11-24). The "mathematization of the world" involved in such a project would no longer be understood as a claim to geometrically access nature and the mode of production of things in favor of the mathematical reconstruction, via algorithms of the nascent differential calculus, of natural phenomena and their causal links (where causal links are now treated in terms of structural causality[17]expressed in differential equations and no longer in terms of a real mechanism of phenomenon production). This change is imposed because of the limitation manifested by the geometrization of movement in the solution of difficulties involving precisely the variation of movement - difficulties that resume, in their own way, the paradoxes of the infinite of Zenon of Elaea to the extent that they demand, beyond the contrast of finite world and infinite God, the reinsertion of the infinite within the finite (MANCOSU, 1966, pp. 118-149; ARTHUR, 2001, pp. xii-lxxxviii and HOLDEN, 2007, pp. 1-5). Regarding this debate, the A*ntinomies of pure reason*, expounded by Kant in the *Critique of pure reason*, can be understood as a kind of final balance of the theses whose opposition constitutes the very core of the debate. Thus, we can characterize such debate as constituted, in last analysis, by the opposition between positions that fall, the first of them, into a fallacy of composition, where the *termini* (the limits) determining the form of a continuous *totum* are conceived as homogeneous to the constituent parts of this *totum* (its multiple). In the case of time, it would be a matter of considering the determining instants of

[15] The comment in Alquié's note is equally enlightening: "According to Descartes, the only simple motion is rectilinear. A God wanting a body to move along a curve would be a God wanting this body to change direction at every instant. Hence the expression: at the same instant, which must be well understood here. We know, [such] is the doctrine of continuous creation, that God creates the world at every instant. On the other hand, the consideration of the instant leads us to take into account only one point of the trajectory: from this point of view the movement is punctual" (DESCARTES, 1973, p. 189, note 1).

[16] It is worth pointing out in passing that the discontinuity in metaphysical order and the continuity in physical order assumed here do not correspond to the discontinuity from a concrete and real point of view and the discontinuity from an abstract and imperfect point of view of Martial Gueroult (GUEROULT, 1968, p. 275 ff.).

[17] That is, in terms of the correlation between possible variations of certain structural components of natural phenomena.

any time segment as being themselves divisible time segments, even if infinitely small time segments. The second position involved, in turn, would fall into the fallacy of division, where one conceives the possible parts of a continuous temporal *totum*, the different temporal segments obtainable by a possible division, as being homogeneous to the termini of the whole and of the different temporal segments obtainable by division, the instants. In such cases, one obtains as a result, respectively, either the impossibility of giving form to a temporal *totum* (that is, the impossibility of determining such temporal segment) or the impossibility of conferring matter to the temporal *totum*, that is, the impossibility of the constitution of temporal magnitudes (temporal *tota continua*, even if relative) from elements that are not endowed with such magnitudes (the instants).[18]

As we know, the difficulties presented about the treatment of time in Descartes concern interpretations that either pretend that time is discontinuous, resulting from the composition of instants,[19] or well want time to be continuous,[20] or well intend time to be a mix of continuity and discontinuity.[21] In this last case, in particular, one will find interpretations susceptible to the problems that affect both those that claim Cartesian time to be absolutely continuous and those that claim it to be absolutely discrete. In such mixed interpretations, one refuses, on the one hand, a certain conception of temporal discontinuity insofar as they consider each part of time as a temporal segment, a very *brevissimo tempore* or moment. From this point of view, it can be said that they want time to be continuous. On the other hand, by force of the thesis of continuous creation, they are forced to assume the independence between the different segments of time and, from this point of view, they would defend a discontinuous (though not discrete) conception of time.

When considering the difficulties presented above, the Cartesian treatment of shock and circular motion requiring an instantaneously continuous creation and the law of inertia, which makes it possible, requiring temporal continuity, one can see that they concern more properly the interpretations that pretend that the Cartesian conception of *time* is solved in the consideration of a single order, that pretend that time, substantively considered, is either continuous, or discrete, or very continuous-discontinuous. In view of this, if it can be shown that the Cartesian analysis of time requires the consideration of two distinct orders, metaphysical and physical, one can finally take the interpretations presented as sometimes confusing the metaphysical order with the physical order and, thus, intending time to be continuous, sometimes confusing the physical order with the metaphysical order and, in this way, intending time to be discrete, and sometimes mixing these two orders, intending time to be continuous-discontinuous. If things happen in this way, one can, in fact, take the first two difficulties (concerning the shock and the circular motion) as referring to the need to take time, in metaphysical order (that is, in the order of consideration of the relations of the creator with the creatures) or in the fundamentals of physics (in the order of considering the relations of the dynamic principle with the system of the world of which it is a principle), as being discrete. In such circumstances, to claim any continuity of time (that is, to claim that the Cartesian "moments" of time are temporal segments, either interdependent or independent of each other) is equivalent to making impossible the determination of any physical phenomenon (and, therefore, the determination of the world system itself) by rendering the intervention of the dynamic principle irrelevant to the system: it is unable to account for the change in the motion of the components, and therefore empties the continued creation of its physical significance, namely that of allowing, for any instant, the determinability of the quantity and direction of motion - determinability which is, in turn, fundamental to the determination of the occurrence and identity of a physical event (a function of the change in motion). One can, therefore, consider that

[18] Geometrically: the impossibility of constituting a line (one-dimensional geometric object) from the aggregation of infinite points (limits of one-dimensional geometric objects that, as limits, have no geometric quantity).

[19] For example, Gueroult, Alquié and Belaval (BELAVAL, 1960, p. 149)

[20] For example, Garber and Arthur.

[21] For example, Beyssade.

doispontos:, Curitiba, São Carlos, volume 16, issue 3, December 2019, pages 1-14
DOI: https://doi.org/10.5380/dp.v16i3.66669t

to claim, in the metaphysical order, the continuity of Cartesian time (that is, to claim that what is valid in the physical order of consideration of time is also valid in the metaphysical order) is equivalent to, as in a fallacy of composition, claiming that the *limits* determining the form of physical time, the forms of continuous temporal segments, are, while homogeneous to these segments, equally temporal.

On the other hand, the third problem, concerning the assumption that any discontinuity in physical time entails the impossibility of constituting units of physical events and, consequently, of constituting the unity of physical events in a world system, is equivalent to the objection to the identification of the parts of time with the instants.[22] In such circumstances, although, in view of the exposition of the metaphysical foundations of the laws of nature, one is obliged, at least at first sight, to understand the independent parts of time as being instants, one could hardly claim that they, being properly the privation of time, can, as the Axiom II of the *geometrical exposition claims*, immediately succeed each other. Even if successive points in time could be determined, such points would not immediately succeed each other. In fact, if the points *A* and *B* are distinct, then, as the *limits* of a continuous one-dimensional quantity, between them there must necessarily be an infinitely divisible segment of time. Thus, to claim that both the "present time" and the time that "immediately preceded it" must be understood in terms of *instants*, would imply the incidence of a fallacy of division, a confusion between the whole and the part or, more precisely, between the foundation of a continuous whole (*the limit*) and the possible parts of it. In this case, to pretend that what is valid in the metaphysical order of time consideration is also valid for the physical order would result in the impossibility of the constitution of any temporal segments and, ultimately, in the dissolution of the very object of physics: the impossibility of the constitution of proper temporal units (temporal segments) entails the impossibility of movement and, *ipso facto*, the impossibility of movement change.

Supposing the above to be plausible, it would remain to examine in more detail the legitimacy of the distinction between a metaphysical treatment of time, in which it is taken as discrete, and the physical treatment of it, where it is taken as continuous. For such clarification, it is necessary to consider article 21 and, particularly, articles 55 to 57 of Part I of the *Principles of Philosophy*.

> And nothing can obscure the evidence of this demonstration, provided we pay attention to the nature of time or the duration of things, which is such that their parts do not depend on each other, nor ever exist simultaneously; and, therefore, from the fact that we exist now it does not follow that we shall also exist in the immediately following time, unless some cause, namely, that which first produced us, as it were [continuously] reproduces us, that is, [conserves] us (DESCARTES, 2002, art. 21, p. 41).
>
> Duration, order, and number are also understood by us with much distinction if we do not mistakenly add to them any concept of substance, but we hold that the duration of everything is only a mode under which we conceive of that thing insofar as it perseveres in being, and, similarly, that neither order nor number is anything different from the things enumerated, but only the mode under which we consider them *(Id., ibid.*, art. 55, p. 71).
>
> And here, in fact, I mean by modes exactly what I meant elsewhere by attributes or qualities. But when I consider that the substance is affected or altered by them, I call them modes; when it can be called such or such from this alteration, I call them qualities; and finally, when I take into account in a more general way only that they are in the substance, I call them attributes. And so, I say that in God there are only attributes, and not properly modes or qualities, because no alteration is to be understood in him. Thus, also that which is never found differently in created things, as existence and duration in the thing that exists and lasts, must be said, not quality or mode, but attribute (*Id., ibid.*, art. 56, pp. 71-73).
>
> However, some are in the very things of which they are said to be attributes or modes; others, it is true, are only in our thinking. Thus, time, when we distinguish it from duration considered in a general way and say that it is the number of the movement, is only a way of thinking. Indeed, we do not understand [there to be] in motion a duration different from that in things not moved, as is evident from the fact that we do not count more time in one body than in another, if the two move, one slowly, the other quickly for an hour, even though the motion is much greater [in one than in the other]. But in order to measure the duration of all things, we compare them with the

[22] Noting that instants are, as far as physical time is concerned, boundaries and not properly parts of time or temporal segments (BEYSSADE, 1979, pp. 135 and 139).

duration of the largest and most uniform movements, from which result the days and years, and we call this duration time. Which, therefore, adds nothing but a way of thinking of duration taken in general (Id., ibid., art. 57, p. 73).

Note that the combination of the above articles, especially that of articles 55 to 57, seems to imply, first, that, since time is not a substantive, the proper use of the notion of time, *distinct from duration considered in general*,[23] is always an adjective usage (as *quantitas*) and not a substantive one (as *quantum*). In this case, one should have in view not so much time itself and its parts (as a *magnitude* or original *quantum* that, prior to all measurement, is what is measured), but the *time of a thing* (as the *magnitude* or determined quantity of its existence, as, therefore, the *quantitas* of a *quantum*, the magnitude of the existence of a thing according to a unit of measurement).[24] Second, admitting that time and/or duration as *quantitas of existence* does not change the thing that exists and persists, it can, or should, be considered as an attribute (analogously to the *main attribute*)[25]a distinct way of conceiving the existent and not something different from it. This thesis, in turn, when combined with the previous one, indicates that the counterpart of the refusal of a substantive use of the notion of time (*tempus materialiter spectatum*) is the refusal that, in such a circumstance, there is any distinction between time, existence, and the thing itself. Since time, in this case, is indiscernible from the existence of the existent, and since existence itself counts as an attribute of existing things,[26] to be worth for the existent what is worth for the principal attribute, time, existence and thing are ultimately one and the same. More than that, it seems reasonable to suppose that time, existence and thing are not only numerically identical (*one and the same thing*), but also qualitatively identical, the difference between them not being even in the mode of presentation but merely logical or nominal (different terms expressing the same content or the same *object in idea*). In other words: there is no proper notion of time as an *original quantum* since, as such, time is absolutely indiscernible from existence and this, in turn, if taken as a *quantum* (i.e., substantively) is equally indiscernible from the existing thing itself (substance). Thus, time, existence and thing would be distinguishable only logically or nominally.[27] Third, it follows that, once taken adjectivally (*tempus formaliter spectatum*), since the quantities of existence of different existents can be diverse, the determination of any *quantitas* of existence (the duration *of* a thing) requires a (common) unit of measurement, which is obtainable only by comparison "with the duration of the largest and most uniform movements". Thus, because the *quantitas* of existence (the quantity or magnitude of the existence *of* a thing) is definable only by means of the *quantitas* of (a) movement, the identification of time, as distinguished from existence *in* existents, to the "number of the movement" is enabled. It is true that, in rule II of the *Rules for the Conduct of the Mind*, Descartes presents the mutual connection between motion and time as being necessary since "one is more or less confusedly encompassed in the representation of the other, so that we cannot represent clearly neither one nor the other, if we think they are mutually isolated". The movement is, therefore, necessarily linked to time because it is not possible to represent "a movement devoid of any duration" (DESCARTES, 1963, p. 147). Note that, to validate

[23] Compare this with the passage in the Summary of the next six meditations, where Descartes considers the "body taken in general" to be a substance, which implies, in the argumentative economy of the Meditations, to consider the body taken in general = *res extensa* (see DESCARTES, 1988a, p. 12).

[24] As in "the time of my life" from *Meditation three* (see quote above), where "*time*" operates as an indicator of a *quantitas* (a magnitude or quantity of a *quantum*) and "my life" operates as an indicator of the quantum (the whole of the meditator's existence as a magnitude that is quantifiable or measurable.

[25] The Cartesian conception of principal attribute had been introduced just before the articles in question, in article 53.

[26] As indicated in article 56.

[27] Although it cannot be developed here, it can be roughly said that the distinction of reason existing between the substance (thing) and its principal attribute can be presented as that in force between the representations A and B, when they differentially represent one and the same individual concept (or even when they are merely different terms for one and the same individual concept). If this is so, then A analytically implies B and B analytically implies A (A is B and B is A), that is, A and B can be reduced to an identity of the type A is A (or B is B). In view of this, it seems possible to say that, in the case of substantivized time and existence, what one gets is the thing itself (individual substance or nature) presented merely by different terms: the thing = (its) existence = (its) time.

what was exposed here, one could effectively say that, in mutual dependence, neither time, as determined *quantitas* of an existence, can be clearly represented without appeal to the movement. Fourth and last, it is obtained that, insofar as the *quantitas* of existence allows itself to be identified with the *quantitas* of the repetition of (a) regular movement, time, distinguished from the existence *in* existing things, even being an attribute, is not in the things themselves, but "only in our thought".

The whole of the above considerations could be synoptically presented in the following terms: if we distinguish time from "duration considered in general" (i.e., from existence and/or persistences *in* existents), we reach the (adjectival) notion of time as *quantitas* of the existence *of* existents. Since the quantity of existence can only be determined as a quantity by some particular metric of motion (division of motion into parts), it can be taken as equivalent to the number of occurrences of the metric unit of motion (seconds, hours, days, years, etc.), being, as such, an attribute dependent on our mode of representation of the thing, being, therefore, only in our thought. Now, if such an analysis is plausible, even if time itself is not clearly given as a *quantum*, because it is constructible or thinkable clearly only as *quantitas* of the existence of things (in the form of number of movement), it seems plausible to suppose that it is in relation to the existence *in* things that the independence and successiveness of the parts of time affirmed in article 21 should be determined. This being the case, it may ultimately be asserted that it is because, in the metaphysical order, the thing in its existence does not ensure its persistence in existence that the instants of time are independent.[28] In other words: it is because there is no possible causal link between existence and possible persistence in existence that the moments of time are independent of each other. Thus, since the different instants of time constitute precisely the different existences possible to the thing (since the diversity of existence is one and the same as the diversity of the instants of time or duration *in the* thing, both differing only nominally),[29] the causal isolation between existing and the possible existences to one and the same thing responds for being the parts of time, metaphysically considered, extrinsic or existentially independent among themselves. Since, in turn, the existential independence of the parts of time (which, as indicated, is nothing more than another way of conceiving the extrinsic nature of existence vis-à-vis the different possible existences to a thing) entail the discontinuity of time, it follows that it is not possible but to take time as being metaphysically discrete.

It is worth, however, to reaffirm: if time, metaphysically considered, must be discontinuous, such cannot be the case of physical time. In fact, the Cartesian principle of inertia presents the *tendency* of bodies to maintain their states of rest or uniform rectilinear motion. This tendency must be understood in terms of the causal determination of future states of bodies from certain initial states (themselves causally determined), safeguarding the non-intervention of external causes. Thus understood, the inertial tendency implies precisely the existence of causal links between existence and the possible existences of a thing, that is, between its existence in a moment and its existence in other moments or successive instants. Then, as the inertial principle implies the refusal of independence or causal isolation of existence vis-à-vis the possible existences for a thing, as this refusal is translated into a refusal of causal independence of moments or parts of time, and as the refusal of independence of moments constitutes the denial of discontinuity in any of its forms, we have that physical time - which is nothing more than the *quantitas* of existence and, therefore, the number of movement, an attribute that "exists only in our thought" - cannot be discontinuous.

Now, if we admit to be, at least partially, clarified the foundation of the metaphysical discontinuity of time (even if it remains to be clarified what grounds the causal isolation of existents), let's consider the foundation of the physical continuity of time. As pointed out earlier, time, to the extent that it is considered distinct

[28] Successivity, on its turn, would result from the requirement of the possible numerical diversification of one and the same thing. Not being able, by absurdity, to be defined in terms of coexistence, it is necessary to take it by ordered or orderable successive existences. If ordered, one can say that, metaphysically, time corresponds to the ordering of the existences of a thing.

[29] See the previous note.

from existence *in* one and the same thing (that is, considered as something distinct from the thing itself), can be nothing but the quantity of the existence of the thing. Since the quantity of an existence requires a unit of measurement and since such a unit must be common in order to ensure the comparability of the diversity of quantities of existence of different things, time, as *quantitas*, is defined in terms of a metric of motion. The determination of a metric of motion, in turn, requires, for the establishment of what will operate as the unit of measurement of time, the division of a *totum* of motion whose identity is given with anteriority in relation to any possible partition of it. Since this division is ultimately a matter of convention[30] according to any regularity occurring in the movement, a *whole* regular movement must be supposed, which is therefore prior to it and independent of it[31] To put it another way: time as the quantum of an existence requires that a *totum* of motion be thought of as given in the form of an indefinitely or infinitely divisible *quantum continuum*, in the form, therefore, of a *totum analyticum*, where the whole is first in relation to the parts, which are merely possible. Thus, just as the *quantitas of existence* is an attribute that exists in "our thought" and not properly in the thing (although, as seen, it has its foundation in the thing metaphysically considered), the *whole* of motion (which, as a, albeit relative, *totum analyticum*, founds the metric of time) and, therefore, time itself, derivatively considered as if it were a *totum* or a physical *quantum* (a quantity whose *quantitas* can or must be determined) exist only "in our thought" (in the form, one can suppose, of a distinction of reason based on the thing).[32]

Assuming that the above sheds some light on the way in which one arrives at the continuity of time as an attribute in "thought" of the physical world, it would still be necessary to return to the metaphysical discontinuity of time. It would be necessary to examine in detail how the metaphysical discontinuity of time, being a function of the causal isolation of existence, turns out to be, in the last analysis, founded on a requirement of coexistence (and, therefore, concomitance) of cause and effect. In particular, it would be necessary to show that such a requirement is, in turn, derivable from a certain conception of substantiality that constitutes the underlying structure of the Cartesian metaphysical system. From this conception of substantiality, it would be necessary, finally, to show that it is the result of an accommodation of the fundamental categorical distinctions inherited from Aristotelian philosophy (primary substance and secondary substance) to the demands of a peculiar theory of representation. Such an examination, however, cannot be carried out here, but remains for a future opportunity.

References

ARTHUR, R. T. W. 1988. Continuous creation, continuous time: a refutation of the alleged descontinuity of cartesian time. *Journal of History of Philosophy*, vol. 26, pp. 349-375.

ARTHUR, R. T. W. 2001. Introduction. *In*: LEIBNIZ, G. W. *The Labyrinth of the continuum: writings on the continuum problem, 1672-1686*, New Haven: Yale University Press.

BELAVAL, Y. 1960. *Leibniz critique de Descartes*. Paris: Gallimard.

BEYSSADE, J-M. 1979. *La philosophie première de Descartes*. Paris: Aubier.

[30] As is the whole of the movement in question. That is: it is about assuming a relative *totum* and a possible division of that whole.

[31] Just as a season corresponds to a possible partition of the translation movement of the Earth according to the regularity of the equinoxes and solstices, a year, which corresponds to the completion of one revolution around the Sun, is nothing more than a possible partition of a whole of regular translation movements (divisible, therefore, into years, decades, centuries, etc.).

[32] In light of the above, the passage from the *third Meditation* quoted above, which combines the infinite divisibility of the time of the meditator's life with the independence of moments of time, should be understood as making an implicit appeal to the prevailing grounding nexus between the metaphysical order of discrete time and the physical order of temporal continuity.

BLAY, M. 1993. *Les raisons de l'infini*. Paris: Gallimard.

CLAVELIN, M. 1974. *The Natural Philosophy of Galileu*: *Essays on the Origins and Formation of the Classical Mechanichs*. Cambridge: MIT Press.

DELLA ROCCA, M. 1996. Spinoza's metaphysical psychology. *In*: GARRET, D. (ed.). *The Cambridge Companion to Spinoza*. Cambridge: Cambridge University Press.

DESCARTES, R. 1897-1910. *Ouevres de Descartes*. Edição C. Adan e P. Tannery. Paris: Cerf, 12 volumes.

DESCARTES, R. 1905. *Principia philosophiae*. *In*: DESCARTES, *Ouevres de Descartes*. Edição C. Adam e P. Tannery. Paris: Cerf, vol. VIII.

DESCARTES, R. 1963. *Régles pour la direction de l'esprit, in* DESCARTES, R. *Oeuvres philosophiques*. Edição F. Alquié. Paris: Garnier, vol. I.

DESCARTES, R. 1963-1973. *Ouevres philosophiques*. Edição F. Alquié. Paris: Garnier, 3 volumes.

DESCARTES, R. 1973. *Les principes de la philosophie*. *In*: DESCARTES, R. *Oeuvres philosophiques*. Edição F. Alquié. Paris: Garnier, vol. III.

DESCARTES, R. 1988a. *Meditações*. 4ª edição. Coleção Os Pensadores. São Paulo: Nova Cultural.

DESCARTES, R. 1988b. O*bjeções e respostas*. 4ª edição. Coleção Os Pensadores. São Paulo: Nova Cultural.

DESCARTES, R. 1991. *The correspondence*. *In:* DESCARTES, R. *The philosophical writtings of Descartes*. Edição John Cottingham. Cambridge: Cambridge University Press, vol. III.

DESCARTES, R. 2002. *Princípios da filosofia: parte I*. Rio de Janeiro: Editora da UFRJ.

DIJKSTERHUIS, E. J. 1986. *The mechanization of the world Picture*. Princeton: Princeton University Press.

ESPINOSA, B. 2015. *Princípios da filosofia cartesiana*. *In*: ESPINOSA. *Princípios da filosofia cartesiana e pensamentos metafísicos*. Belo Horizonte: Autêntica.

GALILEU, G. 2004. *Diálogo sobre os dois máximos sistemas do mundo ptolomaico e copernicano* de1632. São Paulo: Discurso Editorial/Imprensa Oficial.

GARBER, D. 2001. *Descartes embodied*. Cambridge: Cambridge University Press.

GUEROULT, M. 1968. *Descartes selon l'ordre des raisons, I: l'âme et Dieu*. Paris: Aubier.

HOLDEN, T. 2007. *The architecture of matter: Galileo to Kant*. Oxford: Claredon Press.

KANT, I. 2001. *Crítica da razão pura*. Lisboa: Calouste Gulbenkian.

KOYRÉ, A. 1966. Galilée et la loi d'inertie. *In*: KOYRÉ, A. Études *galilléennes*. Paris: Hermann.

KOYRÉ, A. 1973a. *Du monde clos à l'univers infini*. Paris: Gallimard.

KOYRÉ, A. 1973b. Galilée et Platon. *In*: KOYRÉ, A. Études *d'histoire de la pensée scientifique*. Paris: Gallimard.

MANCOSU, P. 1996. *Philosophy of mathematics & mathematical practice in the seventeenth century*. New York: Oxford University Press.

SECADA, J. E. K. 1990. Descartes on time and causality. *The Philosophical Review*, vol. 99, nº 1, pp. 45-72.

doispontos:, Curitiba, São Carlos, volume 16, issue 3, December 2019, pages 1-14
DOI: https://doi.org/10.5380/dp.v16i3.66669t