filosofia unisinos | Unisinos Journal of Philosophy

ISSN 1984-8234

ARTICLE

doi: 10.4013/fsu.2026.272.07

Contradiction and Sufficient Reason as Ontological Principles: The Metaphysical Foundations of Physics in the Institutions Physiques of Émilie Du Châtelet*

Contradição e Razão Suficiente como Princípios Ontológicos: os Fundamentos Metafísicos da Física nas Institutions Physiques de Émilie Du Châtelet

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*The author thanks the *Émilie: Research and Translation Group*. This work was carried out as part of the group's activities, which were supported by the National Council for Scientific and Technological Development (CNPq).

RESUMO: Tradicionalmente, considera-se que Émilie Du Châtelet ofereceu um fundamento metafísico para física nas suas *Institutions Physiques*. Essa interpretação vem sendo contestada em estudos recentes e, no seu lugar, uma abordagem epistêmica tem sido desenvolvida. Não se recusa que a física de Du Châtelet requeira compromissos metafísicos, mas se defende que eles não são fundamentais. Sua principal preocupação seria o método, que constituiria o verdadeiro fundamento da física. Sustento que seus compromissos metafísicos são intrínsecos à sua posição, pois a objetividade a que ela aspira depende do reconhecimento de que os princípios do nosso conhecimento derivam dos princípios da realidade. Para isso, apresento uma análise dos seus princípios de contradição e razão suficiente que indica que eles devem ser considerados, primeiramente, como princípios ontológicos. Enquanto tais, eles fornecem uma base para afirmar que este é o melhor dos mundos possíveis e, portanto, que ele é racionalmente constituído. Sendo racionalmente constituído, as regras de raciocínio são apropriadas para descobrir a verdade.

Palavras-chaves: razão; conhecimento; causação; epistemologia; metafísica.

ABSTRACT: It has been a traditional view that Émilie Du Châtelet provided a metaphysical foundation for physics in her *Institutions Physiques*. Such a view has been challenged by recent scholarship, and an epistemic approach has been developed instead. There is no denial that Du Châtelet's physics relies on metaphysical commitments, but it has been argued that they are not fundamental. Her main concern would be with method, and method would be the true foundation of physics. I argue that her commitments to metaphysics

are intrinsic to her stance, because the objectivity intended by her depends on the acknowledgement that the principles of our knowledge come from the principles of reality. For this, I provide an analysis of her principles of contradiction and sufficient reason that indicates that they must be regarded primarily as ontological principles. Being such principles, they provide the basis for stating that this is the best possible world and, thus, that it is rationally constituted. Being rationally constituted, the rules of reasoning are appropriate to discover the truth.

Keywords: reason; knowledge; causation; epistemology; metaphysic.

1 Introduction

It is common to describe one of the aims of Émilie Du Châtelet's *Institutions Physiques*[1] as an attempt to provide a metaphysical foundation for physics. More specifically, she is said to have tried to completement Newton's natural philosophy with Leibniz's metaphysics. It has been labeled as the "received view" due to its roots in earlier commentaries (see Brading, 2019, p. 8) and may be traced back to the first review of the *Institutions* (Brading, 2019, p. 22, note 21). Criticism of this view has emerged in recent scholarship, bringing new insights into Du Châtelet's philosophy, with special emphasis on her originality in providing a true synthesis of eighteenth-century physics and her understanding of what a foundation of physics should accomplish (Brading, 2019, p. 16; Janiak, 2018, p. 71). Regarding the latter, some scholars argue that her *Institutions Physiques* provides, in fact, an epistemological foundation for physics, not a metaphysical one (Brading, 2019, p. 18; Detlefsen & Janiak, 2018; Silva, 2022, p. 111). I will argue that her novelty is not an epistemological turn for the foundations of sciences, because her approach remains intrinsically metaphysical (in line with Lyssy, 2022, p. 213 but with a different route), but rather her use of metaphysics for the establishment of autonomous scientific knowledge .

Doubts about the metaphysical nature of the foundations proposed in the *Institutions* arise from Du Châtelet's apparent emphasis on the human nature of the first principles throughout its first chapter, entitled "Of the principles of *our* knowledge" (emphasis added) (Brading, 2019, p. 32; Silva, 2022, p. 111); her suggestion that the principle of sufficient reason would be akin to an instrument (Silva, 2022, p. 112); the centrality of method, which would be the true foundation (Brading, 2019, p. 33); the conciseness of her metaphysics (Brading, 2019, p. 47); and the narrowness of her physics (Janiak, 2018, p. 70). Ultimately, her main concerns would be with providing a rational basis for the universe (Detlefsen & Janiak, 2018) and with explaining the causal interaction between bodies (Brading, 2019, p. 54). Her strategy would be more similar to post-Kantian conceptual analysis than to early modern attempts at metaphysical foundations (Brading, 2019, p. 14).

These new readings advance our understanding of the *Institutions*. They lead us to a more detailed analysis of the text, rather than accepting at face value her claims of mere reproducing and compiling of other sources. Specially, they invite us to understand her metaphysics as her own—a particularly relevant point given that one of the main articles on her work criticizes her supposedly poor understanding of Leibniz's ideas (see Iltis, 1977, p. 38).

However, I maintain that Du Châtelet did seek a metaphysical foundation of physics in the *Institutions*. This does not imply it is a book of metaphysics, but rather that it is a book of physics which relies on metaphysical truths about the world. Such truths may seem instrumental because they are, in effect, used as means to an autonomous science, a science that may advance without extensive knowledge of metaphysics. Nevertheless, this is a consequence of Du Châtelet's metaphysics. The apparent independence of the method stems from the metaphysical nature of the first principles, which allow us to assume that sound reasoning cannot deviate from the path leading to truth. If we disregard the metaphysical character of the first principles—if we take them as consequences of our way of knowing—we lose this direct connection between sound reasoning and truth.

[1] This is the title of its second edition, revised and expanded, which appeared in 1742 (Du Châtelet, 1742). The first edition of the work was published in 1740 under the title *Institutions de Physique* (Du Châtelet, 1740). My article is based on the second edition.

Some scholars point to David Hume's philosophy to contrast her philosophy with the one that caused havoc among early modern philosophers by arguing for the inadequacy of our knowledge (for instance, Brading, 2019, p. 35; Paganini, 2022, p. 46). This is an interesting contrast, as the writing periods of Hume's *Treatise of Human Nature* and of Du Châtelet's *Institutions* overlap. Both admired Newton and were critical of the Newtonians, and both were concerned with the foundations of science, although they differed on the sciences each desired to advance (Hume aimed at moral philosophy while Du Châtelet aimed at natural philosophy). If Brading is correct in asserting that Du Châtelet's main concern in the *Institutions* is causation (Brading, 2019, p. 97), then both identified it as the crucial concept for addressing the basis of sciences. However, in another direction, I believe that this contrast helps to explain why Du Châtelet needs metaphysics, as Hume's conclusions, whether genuinely skeptical or not, are rooted in the inversion of importance between metaphysics and epistemology. It is the intrinsic connection between sound reasoning and truth that is lost in Hume's philosophy. Or, at minimum, truth must be understood as a concept of *our* knowledge (see, for instance, Garrett, 2015, p. 158).

I will not examine in detail Hume's philosophy, as it is the subject of extensive scholarly debate with widely varying interpretations, from the attributing radical skepticism based on the contradictions of human nature (Fogelin, 1985; Popkin, 1951) to reconceptualizing knowledge and science based on natural principles (Garrett, 1997; Stroud, 1977) or on empirical institutions dialectally developed (Baier, 1991; Livingston, 1984). Instead, I will use the skeptical imagery of his philosophy as an illustration of the perceived dangers that Du Châtelet likely sought to avoid. Despite contemporary scholarly debate about how we should understand Hume's philosophy, his contemporaries understood him as a radical skeptic concerning theoretical philosophy. Critics of the empiricist tradition took his philosophy as evidence of its fragilities. This image conveys to us the perception of Hume's strategy for the foundations of knowledge. Du Châtelet's allusions to skepticism in the *Institutions* are occasional but indicate that she shares the fears of the theoretical consequences of poorly addressed metaphysics. Her allusions are sparse because skepticism is not an issue that emerges from the *Institutions*, and it does not emerge in virtue of her reliance on an epistemology that is metaphysically constituted—derived not from a "merely" human perspective, but from a rational one.

I will proceed as follows. First, I will argue that Du Châtelet's principles of knowledge—namely, the principles of contradiction and of sufficient reason—are primarily principles of reality and depend on the existence of a rational cause for the world. If there were no such cause, there would be no reason to think that things should be harmonious or even intelligible to us. She is indeed concerned with the intelligibility of the world, but such intelligibility guides us not only through our representation but also through the world itself. There is a reason for the correspondence between our knowledge and the world, and such a reason cannot rest on "our" principles. Rather, our principles work because the world is the way it is, and it is the best possible world. Then, I will argue that her validation of hypotheses as part of the scientific method depends on this being the best possible world, an implication of her principle of sufficient reason that requires an ontological understanding of it. In short, if we were not in the best possible world, we could not rule out the validity of different hypotheses for explaining the same phenomena. Our rules of reasoning would not be a guide to truth, only to action. Our hypotheses would not have probabilities, because there would be no certainty related to truth, only related to "what works." Thus, I will have offered ontological and epistemological reasons for a metaphysical interpretation of the foundations in the *Institutions*.

2 The principles of reality

Du Châtelet presents two principles as universal and primitive, the principle of Contradiction (IP 1.4/19)[2] and the principle of Sufficient Reason (IP 1.8/23). Contradiction is defined as simultaneously affirming and denying the same thing (IP 1.4/19), and we may understand the Principle of Contradiction as stating that truth cannot be contradictory. A sufficient reason, in turn, is a reason that "makes us understand why a thing is the way it is and not otherwise" (IP 1.8/23). Thus, the Principle of Sufficient Reason holds that everything that happens has a sufficient reason for its occurrence.

These two principles explain our world. Contradiction determines what is possible, impossible, and necessary. Mathematical truths are the most immediate example, but there are other truths that Du Châtelet believes that can be inferred from contradiction, such as the impossibility of thinking matter (IP 3.47/71). Sufficient reason, on the other hand, determines what is actual but not necessary, the contingent truths. After all, many things could be different: this text might not exist, or it could be slightly different from what it is. There must be a reason for its existence and its specific characteristics, but such a reason will not exclude the *possibility* of its being otherwise (or not being at all). Thus, this reason cannot be found in contradiction alone.

Du Châtelet presents both principles as sharing the same status (IP 1.8/23): both are originary (*primitives*) and universal. Although she calls the principle of contradiction the "first axiom" (IP 1.4/19), this cannot indicate ontological priority because both principles are necessary for the actuality of the world. Contradiction comes first because it determines the possibilities and the essences of things (IP 2.27/54)—indeed, the essence of a thing is its very possibility (IP 3.38/63-64). However, there would be nothing if there were no reason for some things to exist and others not, and for some events to happen and others not. Contradiction may be logically prior to sufficient reason, as it determines its subjects, but it lacks the power to bring into existence anything that is not necessary. In effect, it lacks the power to bring anything into existence, for the necessary aspects of the world do not constitute a world, unless we accept the possibility of an incomplete world. Real world requires a second axiom, not derived from the first one: sufficient reason.

My statement that contradiction *lacks* the power to bring anything into existence may seem odd because we may be inclined to understand these principles—contradiction and sufficient reason—as propositions or rules that describe the structure of reality but are not themselves real. This would align with an epistemic interpretation of them, in which they characterize our reasoning and, therefore, our description of the world. They could be used as instruments for verification: necessary truths are verified by the principle of contradiction and contingent truths are verified (or at least corroborated) by the principle of sufficient reason. In effect, they function as such tools, but they cannot explain our existence and the existence of the world merely as methodological or epistemological principles because, concerning existence, they operate as *causes*.

Du Châtelet explains reality through God, who conceived and created our world. The principle of contradiction determines the subject of God's intellect (IP 2.23/47; 2.27/54) while the principle of sufficient reason determines God's will (IP 2.25/49; 2.27/55) ('determines' his will as a reason for choosing, as he is a free being). In fact, they constitute God's intellect and will. Du Châtelet is adamant that God does not determine the possibility of things, but that does not imply that things are possible without him. In fact, the possibility of things seems to be their representation:

[2] Reference to the chapter and section followed by the page of the second edition of the *Institutions* (Du Châtelet, 1742).

> Although the essence of things does not depend on God, it does not follow from this that there is anything outside of Him; *for the ideas that represent the possibility of things being essential to God*, and His understanding containing all that is possible, whatever is not found there is impossible. Thus, Divine understanding is the eternal realm of truths, and the *source of possibilities*, just as the divine will is the source of actuality, and of existence. (IP 3.50/74, emphases added)

Du Châtelet may intend to avoid a description of God's work in a manner similar to the demiurge in Plato's *Timaeus*. Although she clearly stated that matter is created, her approach to possibilities might imply that God chooses what is best from pre-existing principles or Ideas. Thus, such clarification is needed to explain that possibilities exist within God as his essential property. It is not just that God represents everything; his representation of everything constitutes their very possibility. The essence of things does not depend on God in the sense that he does not have a choice whether to represent them or not: since he exists, he represents them. But it may be said that there would be no *possibilities* if there were no God, for he is not only the source of existence, but also of possibilities.

It could be argued that what is not found in God's understanding is impossible *because* it is contradictory. This is correct: my point is not that contradiction is not an objective rule, and it is clear from the text that it does not depend on God's will. However, it is also clear that it depends on God's existence. Moreover, it suffices for my argument that contradiction describes what God represents, as it is a description of the structures of reality. Ultimately, our understanding has contradiction as an axiom because it is an axiom of reason itself.

Therefore, the principle of contradiction, as a formulation, is a tool for us to navigate through what is possible and what is necessary, but it is an axiom because it constitutes God's understanding. If there were no God, there would be no objective reason to assume the principle of contradiction as real. We could think of it as a principle for our knowledge but not for reality. On the one hand, it opens the possibility of brute facts—facts that cannot be explained further but seem to call for further reasons. Atoms as extended indivisibles are an example. Du Châtelet argues against philosophers who state them as necessary assumptions and that such necessity exempts them from further explanation. She opposes this view on the basis that the reason for a necessary thing is the contradiction of its opposite, and the divisibility of an extended thing does not imply contradiction (IP 7.121/140). Her argument requires that we align necessity and contradiction, and it would not be an argument about things themselves if such alignment were a product of *our* reason, not of *reason* itself, assuming too that reality is rational—or, in other words, if such alignment pertained only to *our* representation, not to *representation* as such. 'Representation' does not indicate some kind of difference between the thing and its conception (beyond the fact that the thing is different from that which conceives it) because everything is represented—their representation by God is their very possibility (IP 3.50/74). There can be no inherently inconceivable thing, since this would imply an existence that could not be constructed by a reason. '*Our* representation' is adequate to talk about phenomena, which is the final subject of the *Institutions*—explaining Du Châtelet's emphasis on it—but not when addressing substances and eternal truths. On the other hand, we could think of contradiction as a psychological limitation, an aspect of human nature. It is not an anachronistic or exotic consideration, as there were, for instance, speculations on Mathematics as inherently contradictory for us (Bayle, 1991, p. 377; Malezieu, 1722, pp. 147–148). Also, Descartes' hypotheses of atheism and of a malicious demon hint at such scenarios (Descartes, 1984, p. 14). Although there is debate about the range of his doubt, for our purposes it suffices that Mathematics is textually within its realm, which inevitably raises the issue of whether he is conceiving the possibility of falsity in seemingly necessary relations for us or of the inherently fallible character of our reason ("the less powerful they make my original cause, the more likely is that I am so imperfect to be deceived all the time" (Descartes, 1984, p. 14)). In effect, his doctrine of the creation of eternal truths makes such suppositions as valid for speculation, as we should also attribute to God's goodness the alignment of what it is necessary to our reason and what it is necessary in itself. His argument was used against him by Huet, which sought to put faith as basis for truth (Huet, 1741, pp. 269–272).

Sufficient reason is in God too:

> This reason [the sufficient reason for creating this world] is not outside of God, nor antecedent to Him, but He finds it within Himself, for all possible worlds with all their changes and all their differences, representing themselves simultaneously in the divine understanding (§24), it is within Himself that God contemplates them, and it is by contemplating them that He has determined to give existence to the most perfect one, that is to say, to the one in which all parts tend with the most harmony toward a general end. The necessary being is therefore infinitely wise, for it belongs only to a Being whose wisdom is infinite to choose the most perfect. (IP 2.25/50)

Du Châtelet intends to answer not only why God created this world, but why he decided to create anything at all. Even if this is the best possible world, there must be a reason for deciding to create it, since the existence of anything besides God is not necessary.

> He therefore had a reason to determine Himself to create a World, and this reason is *the satisfaction He found in communicating a part of His perfections*: now this satisfaction is all the greater as the world He has created is more perfect, for *the contemplation of perfection is the source of pleasure in intelligent Beings*, the greatest perfection of this world is therefore the sufficient reason which determined the supreme Being to give it existence in preference to all other possible worlds which were inferior to it in perfection. (IP 2.25/49, emphases added)

This world is chosen because it is the most perfect, and it must be chosen because its contemplation brings joy to God. Such reasoning may have interesting consequences for ethics, as pleasure stands for God's final reason for acting, but I will not explore this further. It may be supposed that such satisfaction in the contemplation of perfection must be assumed as a fact of reason. Indeed, we may understand it as the ultimate expression of sufficient reason: it is this desire that explains why everything is the way it is and not otherwise. It explains why there is something instead of nothing (besides God) and why this something is the most perfect.

Of course, this explanation is insufficient to account for the particular things and relations we observe. It is a general explanation—in fact, the most general one. It is the basis for developing the method, as I will argue later. At this point, I want to emphasize its objectivity through God's actions. Ultimately, it is not an abstract rule for choosing, but a desire found within himself. We need to infer abstract rules and establish procedures for identifying what is perfect or more perfect, because our reason functions through reasoning—through inferences from idea to idea—and our senses do not allow us to perceive everything in a clear and distinct manner. However, these rules and procedures are rational insofar as they express or describe to us what is desirable for God, for a perfect reason.

Du Châtelet opens the chapter about God's existence stating that "the study of Nature elevates us to the knowledge of the supreme Being" (IP 2.18/40). It must be read literally: contradiction and sufficient reason are expressions for us of God's intellect and will, and natural philosophy advances through the description of sufficient reason, of God's will. Its definition on its first appearance, as what "makes us understand why a thing is the way it is and not otherwise" (IP 1.8/23), is an expression of nature's rationality—it is comprehensible for rational beings—which comes from its rational cause, God, an intelligent being. We must discover its particular expressions in the natural world. She continues by stating that "this great truth [the supreme Being] […] must be the foundation and the conclusion of all our research." (IP 2.18/40). It is the conclusion because, ultimately, we corroborate that this world is complex in its effects and simple in its causes, that it is compatible with a rational product and incompatible with a non-rational one. The conclusion of our research is the corroboration of the perfect harmony of the world, the basis of the argument from intelligent design for God's existence, the one favored by Newton (Voltaire, 1879, p. 405). And it is the foundation because we start from rationality conceived as a true expression of reality, we start from God.

Therefore, contradiction and sufficient reason are causes of the world because they are the expressions of God's actions as its cause. Contradiction expresses his representation of everything. Sufficient reason expresses his will. Contradiction is the expression of rationality as the limit of reality. Sufficient reason expresses its value or goal, as it is informed by what pleases intelligence.

Before proceeding, I want to discuss Du Châtelet's position that denial of sufficient reason as a principle implies contradiction:

> If we wanted to deny this great principle, we would fall into strange contradictions, for as soon as we admit that something can happen without sufficient reason, we cannot assert of anything that it is the same as it was the moment before, since this thing could change at any moment into another of a different kind; thus there would be for us no truths except for an instant. (IP 1.8/24)

We may speculate whether her use of 'contradiction' is literal, or if she is referring to contradiction in a broader sense, in which denial of sufficient reason would result in a very strange but possible world. On the one hand, a literal use seems inconsistent with her previous statement that it is not less original or fundamental (*primitif*) than contradiction, as it seems to imply that it is derived from it. On the other hand, if the implications of its rejection are possible—if it only implies a very strange world—its foundations seem fragile. An epistemic interpretation would handle it by arguing that it is evidence that she is asking "how is knowledge possible?" and realizing that we need to assume sufficient reason as a starting point. Such an interpretation would be more compelling if she said that we could not be *certain* of anything, not that we fall into contradictions. Moreover, this interpretation does not solve the problem because she is discussing things themselves, not their appearance to us. This is not the distinction made by Kant between phenomena and noumena for claiming that our knowledge concerns the phenomena, because for Du Châtelet our knowledge extends to what Kant would later classify as noumena. She does not separate the question for knowledge from the question for reality:

> Without this principle [sufficient reason] *there would be no identical things*, for two things are identical when one can substitute one for the other, without any change occurring in relation to the property being considered. […] if something could happen without a sufficient reason, I could not pronounce that the weights of these balls are identical, at the very moment that I assert that they are identical; since a change could occur without any reason in one, which would not occur in the other; and consequently their weights would no longer be identical, which is against the definition. (1.8/24-25, emphasis added)

She indeed refers to our judgement ("I could not *pronounce*"; "I *assert*"), but in relation to the things themselves. If we interpret Du Châtelet's question as one concerning knowledge that is not founded on reality—one that infers from knowledge what reality should look like—we put her on Hume's path to skepticism. Hume challenged our knowledge of the world through his analysis of the foundations of causation, which is essentially an analysis of sufficient reason, since a cause is the reason for the existence of a thing. Ultimately, he does not claim that our belief in causation is false or utterly unfounded, but that it is a *moral* certainty (Hume, 1745, Section 26)—'moral' because it comes from custom. That custom has a function in probable reasoning is not itself problematic in early modern philosophy if it has a rational basis—if it is covered by rational certainty that, for instance, everything has a cause for its existence, so that repetition or regularity in experience signals a causal relation. Hume, however, extends moral certainty to belief in causation as a principle, going beyond the admission that experience is necessary to inform us about particular connections or laws. Hume's arguments for putting in question reason as its ground and searching for an alternative foundation are the conceivability of existence with no cause (Hume, 2007, p. 56, THN 1.3.3.3) and the conceivability of irregularities in the course of nature (Hume, 2007, p. 64, THN 1.3.6.11). But, as causation is required for our knowledge, we cannot honestly put it into doubt, but understand how we and other natural beings reason concerning empirical matters (Hume, 2007, p. 118, THN 1.3.15.12). Thus, our knowledge of empirical or causal relations becomes *our* knowledge:

> As to what may be said, that the operations of nature are independent of our thought and reasoning, I allow it; and accordingly have observ'd, that objects bear to each other the relations of contiguity and succession; that like objects may be observ'd in several instances to have like relations; and that all this is independent of, and antecedent to the operations of the understanding. *But if we go any farther, and ascribe a power or necessary connexion to these objects; this is what we can never observe in them, but must draw the idea of it from what we feel internally in contemplating them*. (Hume, 2007, pp. 114–115, THN 1.3.14.28, emphasis added)

Hume does not claim that *we* cannot reason through causes and effects, but that we must be conscious that any supposition of connection is *ours*, belongs to our way of knowing and cannot be properly attributed to the things themselves. Epistemic interpretations of Du Châtelet's principles must address them in a way that does not imply such restraint on her claims of knowledge, for such restraint is associated with skepticism (not with Hume's skepticism, for he did not gained prominence yet when she published the *Institutions*, but his position entailed skepticism because of such restraint).

Du Châtelet's principles do not lead to Hume's problems because, for her, there is no rift between our knowledge and the reality. Error is a matter of bad judgment, not of dissemblance between our way of reasoning and nature's operations. Regarding the excerpt cited, she would disagree with his first sentence, "that the operations of nature are independent of our thought and reasoning, I allow it". They are independent when we take our thought and reasoning as subject to non-rational effects and limitations, but if we understand reasoning as referencing reason itself, nature's operations accord with it. Thus, if causation is part of our reasoning, it is also part of nature. This proposition moves from an epistemic constatation to an ontological one, but such a direction reflects our learning process, not our justification for believing in causal relations in nature. We must assume that there is an opposite movement: if causation is part of nature, it is part of our reasoning. Ontology is the underlying premise that grounds her confidence in the validity of the principles of our knowledge.

Nevertheless, we must still explain Du Châtelet's statement that denial of the principle of sufficient reason leads to contradictions. This cannot mean that it leads to a possible world in which our knowledge does not work, because it would concede the possibility of such a world and grant the basis for Hume's skeptical arguments. Hence, let us assume she means that such a scenario is not a genuine possibility, but a deceptive idea like that of a regular polyhedron of nine faces, which requires considerable effort to recognize as impossible. In the excerpt, Du Châtelet acknowledges that we could have truths *for an instant*. Thus, we might assume that contradiction would still operate and, consequently, that this appears to be a possible world. However, we are discussing a concrete world, not an abstract one. We may conceive an image of one situation and another image of a different situation without considering their connection, but two static images do not constitute an action or compose a whole. We can represent them because an instant requires concern only for its logical construction. In a way, this is similar to our representation of geometry: we do not need to include change in it. However, a concrete world, an *actual* one, requires change. And change requires causes, as it is a contradiction in terms to suppose that something can exist with no cause:

> Since something exists, something must have existed for all eternity, otherwise nothingness, which is only a negation, would have produced all that exists, *which is a contradiction in terms*, for it is to say that a thing has been produced, while nevertheless acknowledging no cause for its existence. (IP 2.19/41, emphasis added).

This excerpt comes from her argument for God's existence, but it is relevant for perceiving that she associates causation with contradiction, specifically, the causal principle which states that every existence must have a cause for its existence. Thus, any representation of a moment with no reference or connection to any other is an incomplete representation; it does not constitute a possible world. From Du Châtelet's perspective, Hume's claim that he conceives an existence without any cause must stem from a confusion about what is being conceived: he mistakes an abstraction for reality. This is similar to Descartes confusion about the essence of bodies:

> It was by following this principle that this Philosopher [Descartes] was mistaken about the essence of Body, which he made consist only in extension, because *he believed he had in extension a clear and distinct idea of Body*, *without troubling himself to prove the possibility of this idea*, that we will soon see to be very incomplete, since we must add to it the force of inertia, and the active force. (IP 1.2/17-18, emphasis added)

There is a clear and distinct idea of extension—if there were not, geometry would be founded on confusion—but extension alone cannot constitute a body because it cannot account for all its properties, particularly motion (IP 8.140/165). Likewise, we may have a clear and distinct idea of a thing, but such an idea does not account for its existence.

'Existence' seems to be the crucial point. For Hume, we have no distinct idea of existence: conceiving an object is conceiving its existence (Hume, 2007, p. 66 THN 1.3.7.2). 'Belief' is what makes us to consider it real or not, and belief concerns our manner of conceiving—our feeling it—not the content of conception (Hume, 2007, p. 68 THN 1.3.7.7). For Du Châtelet, conception of anything does not include its existence; existence is its complement (IP 3.34/60). If existence were included in conception, it would be part of the thing's essence and, thus, inseparable from it (IP 3.38/64): the thing would exist necessarily. Therefore, conceiving something is different from conceiving it as existing. We add something that was not there before. Thus, claiming the existence of something becomes "to say that a thing *has been produced*, while nevertheless acknowledging no cause for its existence" (IP 2.19/41, emphasis added), because we connected its essence with existence. Similarly, conceiving an existence is conceiving a becoming.

This does not fully resolve the issue, as we could explore numerous additional details of the discussion, but it points to a sophisticated understanding of 'possibility'. At first glance, it seems that anything that can be described without contradiction may exist, as that appears to be the meaning of 'possible'. However, we may describe ideas that cannot exist. Extension, as we have seen, is a coherent idea that cannot become actual without being complemented by force: there is no possible world in which matter is only extension, for in such a world there would be no movement and, thus, no change. It is possible as a geometric representation, but it cannot exist. In fact, it is an abstraction, formed by directing of our attention to one aspect of a notion while disregarding the rest (IP 5.77/102) (a description that is interestingly closer to Berkeley's than to Locke's approach to abstract ideas). Therefore, extension considered in isolation is a being of reason, a being that cannot exist because it is incompatible with existence. It is an impossible *thing*, but not an impossible idea or representation.

Du Châtelet's frequently alludes to geometric examples to talk about modalities, so it might be argued that my exposition contains a fundamental flaw. Indeed, my interpretation requires contextualizing such examples: they must be understood as useful for comprehending the meaning of modalities, but they cannot be examples of possible *things*. It is a strong demand, but it resonates with her allegation that Newtonians confounded physical space with geometrical space (IP 5.78/104).

We may conclude that the limits of our thoughts are not the limits of existence. When we abstract existence from things, we may conceive many abstract entities that, although logically constructible, are incompatible with an actual world. Geometry, for instance, is valid for any possible world, but all its objects are abstractions that must be complemented to constitute a world. A geometer abstracts, among many things, existence.

Du Châtelet's allusion to Archimedes is informative.

> Archimedes, moving from Geometry to Mechanics, well recognized the need for sufficient reason; for wanting to demonstrate that a balance with equal arms loaded with equal weights would remain in equilibrium, he showed that in this equality of arms and weights the balance must remain at rest, because there would be no sufficient reason why one of the arms should descend rather than the other. (IP 1.8/26)

Archimedes reasoning appears to be simply the affirmation of an equality, but it contains an additional element: that such equality must be valid for an object in the absence of a reason to the contrary. This step to mechanics acknowledges that reality adds a layer of complexity to our reasoning, for it involves causes for existence. What might seem like pure logical affirmation reveals itself to be a factual one.

The principle of contradiction indicates to us the principle of sufficient reason because we recognize that essences require something else to become actual. We recognize that existence is an addition, that beings other than God are compatible with existence but do not have existence in their essence. Just as we demand a demonstration of a geometrical truth, we also demand a demonstration of a union between an essence and existence. We demand a cause. However, we demand it because of the fact of existence. The existence of finite things is not necessary: God could be satisfied in contemplating his own representations. Contradiction does not depend on the existence of anything other than God to operate. Sufficient reason operates insofar as God contemplates the possible worlds to create an actual one. It becomes a principle through his desire to communicate his perfection, through his construction of an actual world. Like an artisan, he entertains geometry but cannot be satisfied by it. His work involves change.

Thus, we may accept that sufficient reason is necessary insofar as far as existence is concerned. If we deny it, we might consider as possibilities scenarios in which there is no account for the existence of essences. We would be claiming that things come into being without truly coming to being. However, sufficient reason surpasses contradiction and cannot be reduced to it because what actually constitutes sufficient depends on the characterization of perfection that equates it to simplicity of rules and diversity of effects (IP 2.27/51). From such characterization follows rules that surpass the maxim that *ex nihilo nihil fit*, for it is a way to state that nature does nothing in vain.

Moreover, it may be said that sufficient reason is a condition for applying contradiction to existence, for Du Châtelet claims that its denial would imply that truth would be uncertain even at the moments they are professed: "if something could happen without a sufficient reason, I could not pronounce that the weights of these balls are identical, *at the very moment* that I assert that they are identical" (IP 1.8/24-25, emphasis added). An assertion of factual identity is not equivalent to a logical one, for it concerns not possible essences, but actual ones. We suppose that reality conforms to logic, but it is not beyond speculation that logic might be merely a human product. Indeed, she writes:

> Without the principle of sufficient reason, one could no longer say that this Universe, whose parts are so well connected to each other, could only have been produced by a supreme wisdom, for if there can be effects without sufficient reason, all this could have been produced by chance, that is to say, by nothing. (IP 1.8/25)

As we have seen, chance as a cause is a contradiction in terms. Sufficient reason may be the bridge to consider contradiction as valid for existence as well.

If all this reasoning about contradiction and sufficient reason has adherence at least to the core of Du Châtelet's position, it signals that her stance depends on deep metaphysical commitments. Her epistemic approach does not imply a prevalence of epistemology over metaphysics, because her metaphysics is the underlying condition for the validity of epistemology as she intended it to be valid: for things, not just for their appearance.

3 From metaphysics to physics

Du Châtelet understands reality through three layers: the metaphysical, the mechanical, and the physical. Metaphysics is the domain of substances. It is important for physics insofar as it gives us the fundamental properties of being. Force, for instance, is a concept established by sufficient reason, for it is needed to account for action and reaction (IP 8.142/166). It establishes mechanism as a paradigm (IP 8.146/169), because it establishes extension and force as the essence of matter. Mechanics, thus, is the domain of bodies conceived as extended things with active and passive forces. It is phenomenal, as bodies are a product for us of the metaphysical union of the substances (IP 7.133/154): if we had a divine perception, we would not perceive bodies. She calls mechanical causes 'distant reasons' because they do not present themselves in experience (IP 9.179/200-201). We discover them through reason, although we need experience to corroborate it: that is the way of hypotheses. Finally, physics is the domain of qualities or causes that are not reduced to mechanics (IP 9.180/201). She calls them 'close reasons', for their proximity to us. Du Châtelet states that we do not need to go beyond them to have knowledge (IP 9.182/204). This remarkable affirmation, which denotes the autonomy of physics as a field, requires her heavy metaphysical commitments.

First, let us understand what a physical cause is. It is an elaboration of the phenomena that gives us some insight into how things work. For instance, the Copernican System may be considered a physical cause, as it gives us answers to our astronomical questions. Why does Venus exhibit such a motion in the sky throughout the years? Because Venus and Earth orbit the Sun. How do we know this? Because the observed positions of Venus throughout the years are consistent with our supposition and are not with its rejection. Venus, Earth, and the Sun are all observable entities. The data compiled to formulate the model are also observable. The Copernican model constitutes a physical cause, or a close reason, for the observed motion of celestial bodies. It gives us an understanding of their behavior. It organizes our observations: they appear to us the way they do because they move in accordance with the Copernican model. It does not go so far to reveal to us how it can be mechanically reproduced—it is not a mechanical cause—but it enlightens us about the superficial appearance of phenomena.

However, one may question the basis of our confidence that such a process leads us to truth, and not to illusion. The mathematical devices of Copernicus may be consistent with the observations, but we could think of alternatives for the movement of celestial bodies. The answer lies in a consequence of sufficient reason: that this world is such that nothing is in vain. Thus, if the Copernican model explains our experience in the simplest way, it is closer to the truth than any other.

Let us trace the route from sufficient reason to the best possible world. Let us assume that everything must have a reason for its existence. That is where we stopped. Someone may challenge that such a reason must be 'sufficient'. However, since a sufficient reason is a reason that shows us "why such thing is this way and not other" (IP 1.8/23), it seems that a real reason must be sufficient. We may understand 'a reason', without the complement 'sufficient', as part of a wider explanation: it needs something else—other 'reasons'—to explain or produce the effect. And we may understand it also as a valid supposition, one that still needs corroboration but is worth consideration. The latter pertains only to epistemology, for explaining our process of thought. The former may be considered in metaphysics to understand complex beings, but cannot be admitted as a true cause, because a cause must produce its effect (a challenge of this maxim will only arise during the 20th century, at least in European philosophy (for instance, Anscombe, 1986)). Thus, strictly speaking, a cause or a reason is the composition—when it is the case—that produces the effect. Admitting a 'partial' cause would be equal to accept chance as a cause.

Moreover, as it is admitted that this world has a rational and perfect cause, a sufficient reason must also be the *best* reason. For instance, a sufficient reason for choosing one option over another is *the* reason for choosing. While we may colloquially say that we could have had reasons for choosing differently, these are reasons in a broader sense. Strictly speaking, they are not genuine reasons, as they lack the force to explain the action taken. We may consider them as potential reasons during deliberation. However, when we choose to act differently, we conclude that they are not actually reasons.

One might argue that a conceptual confusion surrounds the notion of "sufficiency". After all, the best may be considered excessive, exceeding what is truly necessary for something to be sufficient: the best is sufficient, but sufficient is not necessarily the best. This discussion necessitates a metaphysical perspective on reason, a perspective that supposes that reason cannot lead to multiple, equally valid paths. The existence of two equally rational paths implies the impossibility of decision on a purely rational basis. It implies that non-rational factors are necessarily needed to solve such a situation. Concerning two good options, two colloquially sufficient options, the better is the best. It is rational to prefer the better. Therefore, if there is a better reason, *that* is the reason—only the best suffices reason. An indifference to a supposedly better reason must contain a hidden cause. For example, I may say that I am indifferent to acquiring the absolute best jacket, content with one that is pretty and comfortable. My apparent indifference stems from some other factor than the quality of the jacket in my decision, such as a desire to minimize money or time investment. These factors compose my deliberation and constitute the reason for my choice. My "best" was a combination of beauty, comfort, and time and money saving.

The best physical world is the most efficient machine. If it were not the most efficient, it would lack something; it would contain some element of irrationality. There exists no reason to prefer a less perfect machine: such a preference would be irrational. If this were not the most efficient machine, it would not be a rational world.

The Principle of Sufficient Reason, along with its implication that this is the best possible world, allows us to regard the rules of reasoning as objective principles. On this, I agree with Silva, who states that:

> ...the epistemology underlying her writings suggests a reformulation in the understanding of the epistemological foundation of experimental philosophy: for Du Châtelet, experimental philosophy can use experience as a method in the search for truth as long as it is supported by the principle of sufficient reason. (Silva, 2022, p. 119)

I am stating that the principle of sufficient reason is crucial for taking experience as a method for truth. And it is by this same reason that I disagree with attempts to deflate the importance of metaphysics for the *Institutions*: Du Châtelet provides a truly metaphysical foundation for physics, for its epistemology requires it in letter and in spirit. On this, I disagree with Silva (see Silva, 2022, p. 111, footnote) and agree with Lyssy, that writes that "both Du Châtelet and Leibniz think that we need to include true metaphysical principles instead of merely heuristic epistemic principles in our explanation, and we need to understand the metaphysical nature of forces as well." (Lyssy, 2022, p. 213). For instance, we may wonder whether our preference for simpler hypotheses is merely pragmatic. If two hypotheses predict the same phenomena, and one is simpler than the other, which one should we prefer? If we believe that nature does nothing in vain—that is, that nature does not do anything without a reason—we may conclude that the simpler hypothesis is closer to the *truth*. After all, there is no reason to use additional resources when the same effect can be achieved with fewer. To argue against this is to argue against the rationality of nature.

The objectivity of sufficient reason validates our way of reasoning. We can be sure that when a hypothesis explains a phenomenon with some success, it is a step towards truth. Ptolemy's hypothesis explained celestial phenomena better than any other available in his time. (One could point to the heliocentric hypothesis of Aristarchus of Samos as a counterclaim; however, it must be proved that his hypothesis had a similar mathematical treatment and complexity as Ptolemy's. Aristarchus' work on the matter is lost, thus we cannot solve the issue) Although ultimately false, it was a step toward the truth. It would be overly cautious to reject it at that time. In Du Châtelet's approach, a hypothesis has instrumental value: its importance lies in its utility for advancing knowledge. As she writes, it is like a temporary binder (IP Avant-propos.VIII/9): we cannot build the edifice of knowledge without it. Also, it would be excessively confident to take Ptolemy's hypothesis as the truth even in his time, given its inaccuracies. In retrospect, it *ought to have been* inaccurate. A false hypothesis that perfectly explains the phenomena must be ruled out. It would break the connection between reasoning and truth, implying a component of chance in choosing the right theory. After all, a hypothesis may be instrumental, but knowledge itself is not. Knowledge is not merely what works; rather what works is a signal of knowledge. Ptolemy's model was more probable than any previous formulation, but its inaccuracies indicated that it required further refinement or contained an essential flaw. Copernicus, therefore, hinted at its essential flaw, the assumption that Earth was immobile, and proposed an alternative with mathematical support. New evidence corroborated the falsity of that assumption. Kepler refined Copernicus's model by discovering the elliptical nature of planetary motion. Ultimately, Newton advanced the model further, unifying the celestial and terrestrial motions. This is all a road to the truth.

We must be conscious that these theories did not uncover the mechanical reasons of phenomena. Ptolemy, Copernicus, Kepler, and Newton dealt with the physical causes, or alternatively we may say that the truth in their theories lies in the physical realm. We may be confident in the increasing probability of their theories because each of them explained better the phenomena. Each developed a theory more precise than the previous one, and, in Newton's case, a broader one. It would be astonishing if this movement did not lead to truer theories. In fact, it could be a refutation of Du Châtelet's approach, because it would complicate the connection between, on the one hand, our experience and reason, and, on the other, the world. She presents a historical view of science, but this history must lead to the truth. An argument demonstrating that we might consistently refine incorrect theories without ever approaching the true account of the world would erode the basis of her validation of physical theories that are not actually reduced to mechanical ones. Nonetheless, Du Châtelet can justify a physical theory that does not deal with, or deals insufficiently with, the inner workings of nature because her metaphysics is structured in such a way that such a theory cannot get its probability by chance. We may be sure about our account of the "superficial" reality because it cannot mislead us if we judge properly.

My conclusion about Du Châtelet's epistemology is essentially distinct from that of Gianni Paganini, who has an enlightening study on the rules for reasoning in the *Institutions* (Paganini, 2022, pp. 33–39). He concludes that she is a fallibilist and that "even attraction" is "a provisional hypothesis … that might be replaced by a new theory based on impulsion" (Paganini, 2022, p. 49). There is a confusion of levels: attraction as a valid hypothesis is not about the realm where impulsion reigns. Du Châtelet hopes that attraction as a physical cause be eventually explained by a mechanical cause, that is, by impulsion. Conception of attraction as a rival to impulsion is founded on a misconception of their nature: Cartesians are unjustified to reject it as a physical description of the phenomena and Newtonians are unjustified to admit it as the final word or the ultimate description of the world.

Moreover, the fact that Du Châtelet is open to the possibility of error or improvement does not entail fallibilism as a methodological or scientific instance. The growth of probability to reach even certainty (see IP 4.58/84 about Huygens supposition) is incompatible with a cautious and negative attitude but entails a belief that truth is in our reach. Du Châtelet does not goes into length to explain how she conceives 'probability', but it seems safe to assume that she shares Locke's understanding of it, as "likeness to be true" (Locke, 1979, p. 655, book 4, chapter 15, section 3), as she explains the road to truth using hypotheses as one going from "verisimilitude to verisimilitude" (IP 4.55/80). This is not a chain of statistical inferences, but of informed guesses according to imperfect proofs or evidence. In a world of uncountable possibilities, we need to ignore those which are mere possibilities and identify those which deserve our consideration: they are probable. A possibility can even become certain: we know that it is not logically necessary, but we are certain that it is true. It is true because of God's will, not because of God's representation. This is one of the aspects of *our* knowledge. If we had a divine intellect, everything that follows from the principle of sufficient reason would be equally certain for us, as we would understand how every other possibility than what is actual would not amount to any probability. Logical contingency raises us doubt because we cannot inspect all the intricacies of reality.

4 Conclusion

Du Châtelet's approach to science establishes its objectivity through metaphysics. Natural philosophers rely on metaphysics to grasp the fundamental principles of knowledge and of physics. However, they do not need to resolve specific metaphysical problems to advance physical theories, as their focus lies in a different realm of reality. They can trust the metaphysical principles as they trust the geometrical truths: assuming them, not remaking their proofs. Thus, when a hypothesis works, they can trust that it expresses something true or closer to the truth.

My disagreement with other scholars lies in the significance of metaphysics. Du Châtelet's synthetical approach and focus on the methodological consequences do not imply a less committed metaphysical position. Her position on the autonomy of physics may lead us to think that she was searching for less metaphysical physics, but that is only partially true. It is true that she validated experience as a source of knowledge, but she did it by articulating it through metaphysics that allows for such reliance. It is this articulation that seems to be Du Châtelet's great insight to understand and synthesize the physics of her time, and, in effect, establish a new way of thinking.

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Declaração de Disponibilidade de Dados:
Todo o conjunto de dados que dá suporte aos resultados deste estudo foi publicado no próprio artigo.

Submetido: 11 de abril de 2025.
Aceito: 11 de maio de 2026.