Du Châtelet on Sufficient Reason and Empirical Explanation

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Abstract: For Emilie Du Châtelet, I argue, a central role of the principle of sufficient reason is to discriminate between better and worse explanations. Her principle of sufficient reason does not play this for just any conceivable intellect: it specifically enables understanding for minds like ours. She develops this idea in terms of two criteria for the success of our explanations: 'understanding how' and 'understanding why.' These criteria can respectively be connected to the *determinateness* and *contrastivity* of explanations. The crucial role Du Châtelet's principle of sufficient reason plays in identifying good explanations is often overlooked in the literature, or run together with questions about the justification or likelihood of explanations. An auxiliary goal of the paper is to situate Du Châtelet's principle of sufficient reason with respect to some of the general epistemological and metaphysical commitments of her *Institutions de Physique*, clarifying how it fits into the broader project of that work.

Consider a balance with equal weights in each pan. The balance, other things being equal, will be at rest. Emilie Du Châtelet contends that this assumption involves the idea that "there was not sufficient reason why one of the arms should tilt rather than the other" (IP I.8/ZB 130).[1] It

[1] On this example compare Leibniz (1989, 321–22), Mach (1919, 8–23), and Della Rocca (2010, 2). I cite the 1740 and 1742 editions of the *Institutions* by chapter and section. When available, I use (and cite by page) the 2009 translations by Isabelle Bour and Judith Zinsser. All other translations of Du Châtelet are my own, though I have consulted the English version of the *Institutions* by Katherine Brading et al., available at https://www.kbrading.org/translations.

seems intuitive that if the balance begins to move, there must be some reason or explanation for this. It is less obvious, however, what this intuition amounts to, or what it is based on.

Du Châtelet holds that our assumptions about how the balance behaves follow in some way from the principle of sufficient reason (henceforth 'PSR'). In fact, "all contingent truths depend" on this principle (IP I.8/ZB 128). But Du Châtelet's point is not that all truths can be logically derived from the PSR alone. So what could it mean for all contingent truths to *depend* on such a principle? A standard reading focuses on justification and certainty: the PSR shows that our beliefs about contingent facts are not undercut by various defeaters, so the PSR grounds certainty in these beliefs (Moriarty 2006; Zinsser 2006, 174; Reichenberger 2012; Brading 2019, 26–53). While I grant that Du Châtelet takes her PSR to increase the justification of our beliefs, especially by warding off skeptical threats, this does not exhaust the principle's significance for our explanatory practices.

I will argue that Du Châtelet's PSR plays an additional, crucial role. The PSR aids in discriminating good empirical explanations, including hypotheses. It tells good explanations from bad by setting standards of contrastivity and determinacy—respectively, the way in which explanations allow us to understand *how* and *why* something is the case. Although Du Châtelet often focuses on efficient-causal explanation, she does not define the PSR, or explanatory success, in strictly causal terms. And she regards mathematical precision as helpful, but not strictly essential, for enabling understanding how and why.

I take my account to complement recent work on Du Châtelet's influence on later eighteenth-century thought, such as the French *Encyclopédie* and the German Enlightenment (Maglo 2008; Roe 2018; Hagengruber and Hecht 2019). My main focus, however, is on laying out the contours of Du Châtelet's philosophical position, rather than assessing its legacy. If her endorsement of the PSR makes Du Châtelet a rationalist of some kind, I hope to show she has a particularly compelling account of rationalism's significance for our explanatory practices.

Principles of sufficient reason are a mainstay of early modern rationalism. And they have recently seen a revival. But it is often obscure precisely what consequences they have for our actual practices of empirical explanation. For, from the claim that there is a reason for everything, it does not follow that we can grasp the reasons in question; some rationalists, such as Leibniz, explicitly hold that most of the reasons the PSR guarantees to exist are unknowable for us. Du Châtelet, by contrast, makes manifest how her principle of sufficient reason grounds

criteria for evaluating empirical explanations. And what it means to understand how and why contingent facts obtain is partly grounded in the epistemic capacities of subjects like us. Her version of the PSR occupies an attractive middle ground between triviality (where a PSR would fail help us discriminate between good and bad explanations) and overdemandingness (where a PSR would exclude a priori types of explanation that are reliable or even indispensable).

The paper is organized as follows. In the next section, I outline some core features of Du Châtelet's PSR. I focus on its explanatory import, and especially on how this principle can build in a rich conception of what it means for a finite cognitive subject to be able to understand a truth. Then section 2 introduces the PSR's role in discriminating good explanations, via case studies of some of Du Châtelet's examples. The main focus will be on laying out what contrastivity and determinacy amount to, and on how these properties contribute to explanation. More briefly, the section considers the roles Du Châtelet assigns to mathematical precision and causal concreteness: they aid in explanation but are not essential for it.

Finally, in section 3, I contextualize this account of the PSR in terms of some broader epistemological commitments of Du Châtelet's *Institutions de Physique* (1740, 1742). For Du Châtelet, empirical claims are merely probable. The PSR assists in reasoning under conditions of uncertainty. This epistemological context in turn makes it easier to situate Du Châtelet's PSR with respect to predecessors such as Newton and Wolff. Fully contextualizing her position is beyond the scope of this paper. But I make some provisional remarks on how, on my reading, Du Châtelet's PSR complements both her positive stance on Newtonian non-deductive inferences, and her decision not to follow Christian Wolff in seeking to ground empirical physics in a substantive metaphysical or 'rational' physics.

1. Introducing Du Châtelet's Principle of Sufficient Reason

In this section, I aim to shed some light on how Du Châtelet's PSR—as an apparently a priori, rational principle—can have enough content to pick out better and worse empirical explanations. The answer, in brief, is that the PSR builds in a rich conception of understanding.

It will be worth initially stepping back to consider two kinds of justificatory question that can be asked about principles of sufficient reason. First, one can ask whether and how the PSR might be grounded, for instance in a fundamental principle 'upstream' of it. But there are also important 'downstream' questions concerning the utility or applicability of the PSR for *our*

actual practices of explanation (Detlefsen 2017; Brading 2019). Such questions also bear on the justification of the PSR. If the application of the PSR could be shown to be indispensable for the success of physics or some other respected mode of inquiry, this could count as a regressive justification of the PSR.

Christian Wolff provides a historical illustration of the way these questions about the PSR can come apart. He seeks to ground the PSR in the principle of contradiction, while also taking it to play a fundamental role in proper scientific explanation.[2] These are independent claims. Even if Wolff fails to derive the PSR from the principle of contradiction, his rationalist account of scientific explanation might stand.

I will focus on the second, downstream type of question. One reason for doing so is historical. At least part of Du Châtelet's motivation for discussing the PSR in the *Institutions* stems from the value she takes the principle to have for our practices of empirical explanation. In 1738, she pulled an early version of the *Institutions* from the presses, partly in order to add material on Leibnizian and Wolffian metaphysics. The additions very likely include the discussion of the PSR that we find in the 1740 published version of the work (IP, 'Avertissement'; Barber 2006/1967; Locqueneux 1995, 867). Yet as a number of commentators have stressed, and as I will discuss further in section 3 below, the published *Institutions* retains a broadly Newtonian focus on empirical explanation, suggesting that the PSR somehow fits into the work's account of empirical explanation (Hutton 2004; Rey 2013; Brading 2019).[3]

This second kind of question is also philosophically important. If the PSR does not have clear implications for our actual explanatory practices, it is threatened with a kind of triviality. Even granting that there are no brute or ungrounded facts, for example, we can still ask what significance this has for cognizers like us. As I'll discuss in section 2, Du Châtelet calls attention to the relative ease with which we can come up with hypothetical grounds for facts. But this does not yet settle whether these putative grounds or explanations are *good* or valuable.

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[2] See Wolff (1977/1730, §70; 1720, §§29–36); Dyck (2020, 101–2). By January 1737, Du Châtelet possessed a partial French translation of the latter work (Locqueneux 1995, 865; Neumann 2014). Du Châtelet also read some of Leibniz's most important papers, and his correspondence with Clarke (Zinsser 2006, 120–1; 173). Leibniz suggests the PSR could be derived from a more basic theoretical commitment—not the principle of contradiction, but his predicate-in-subject theory of truth (Leibniz 1989, 31). On the PSR in Wolff and Leibniz see e.g. Casula (1979), Sleigh (1983), Perin (2015), and Harrop (2020).

[3] At least in early work, Du Châtelet lists Wolff among authors of "physical" treatises, such as 's Gravesande, Musschenbroek, and Keill (1738, 541). She repeatedly complains that Continental Newtonian treatises are inadequate, but frames the *Institutions* as filling that gap (2018, 1:336; I:500–1). So it is far from obvious that Du Châtelet saw a sharp opposition between what would later be called Continental rationalism and British empiricism.

Du Châtelet's account of the PSR unfolds over several pages in Chapter 1 of the *Institutions*. To begin with the scope of the principle, it is presented as "the foundation of all contingent truths," whereas strictly necessary truths are referred to the principle of contradiction. (IP I.7–8/ZB 128). The contingent truths she has in mind include truths about *modes*: ways a substance might be that are not necessitated by its essence. To use Du Châtelet's example, it is not essential to me that I am currently standing up rather than sitting or lying down; "there must be a sufficient reason why" I am now one way rather than the other (IP I.8/ZB 130).

While this is not the place to settle exactly what counts as a contingent truth for Du Châtelet, when we look at the way the PSR is actually used in the *Institutions*, it most commonly applies to *empirically* contingent propositions. For example, the principle is used to investigate "why certain changes are possible in bodies, how these changes become actual, and why some instead of others occur" (IP VIII.145). The answers to these why-questions will appeal not just to particular matters of fact, but to general laws. The counterpart to Newton's Law II in the *Institutions* even includes a reference to sufficient reason (IP XI.229/ZB 177; Reichenberger 2018).

A sufficient reason is one that "makes us understand why this thing is what it is, rather than something completely different" (IP I.8/ZB129; cf. IP I.9/ZB 131). Note that Du Châtelet's PSR is modalized: it does not guarantee that we will in fact understand the sufficient reason for any given contingent truth, but only that an intelligent being "could understand [*puisse comprendre*]" the reasons in question (IP I.9/ZB 131; translation modified).[4] Sometimes she puts the point negatively: for any contingent truth, we cannot demonstrate that it *lacks* a sufficient reason (IP I.9/ZB 131).

So Du Châtelet's version of the PSR can be summarized as follows: *any contingent truth has a sufficient reason, by which an intelligent being could understand why it is true*. This rough summary leaves many interpretive questions open. I will focus on two issues that are particularly relevant to the empirical, explanatory implications of the PSR. First, I will consider what Du Châtelet means by the related notions of a truth and a reason. Then, I will offer an interpretation of the role played by an intelligent being's ability to understand something.

[4] Along with understanding as a verb (*comprendre*), Du Châtelet also discusses the faculty of understanding (*entendement*) (IP II.23/ZB 142). This distinction is hard to capture in English translation. Here I focus on how she uses '*comprendre*' to explicate the PSR.

i. *Truths and sufficient reasons*. The significance of Du Châtelet's PSR is not only explanatory and epistemic, but metaphysical. While this is a point of emerging consensus in the literature, it is nonetheless worth spelling out. In contemporary Anglophone philosophy, 'reasons' are often understood as propositions or sentences. But many early modern thinkers use term more broadly, encompassing what we might now call metaphysical grounds.[5] The Latin '*ratio*' and the German '*Grund*' were used in a metaphysical sense, as well as to designate an explanatory, epistemic, or inferential ground.[6] The same goes for Du Châtelet's '*raison*.'

The notion of a 'truth' is more straightforwardly connected to what an "intelligent being" can "understand," such as judgments or propositions (IP I.9/ZB 131). But Du Châtelet's discussion of the PSR implies that judgments, to the extent that they are true, allow us to understand actual, concrete things and their laws. Often, what grounds a judgment's truth will not itself be a judgment.

Du Châtelet introduces her PSR through examples that invoke metaphysical grounds, rather than mere epistemic or explanatory reasons:

> I declare that all is still in my room in the state in which I left it, because I am certain that no one has entered since I left; but if the principle of sufficient reason does not apply, my certainty becomes a chimera, since everything could have been thrown into confusion in my room, without anyone having entered who was able to turn it upside down. (IP I.8/ZB 129; IP I.8/ZB 130)

The violation of the PSR considered here is an *effect* (the messy room) without a cause, rather than a mere belief or judgment that lacks justification. Another relevant example appeared at the beginning of the paper: Du Châtelet considers the reason why a pair of equally massive lead and stone spheres can be switched on a balance without the pans changing position. The *reason* for this has to do with causal and constitutive features of the spheres and balance, and with the laws of nature—not just with our judgments.

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[5] English also permits using 'reason' in causal or metaphysical senses, as in the following example from Broome (2013, 46): "The reason stars twinkle is movements in the intervening air." However, recent philosophical attention has focused on what Broome calls *motivating* and *normative* reasons. Philosophers today are more likely to treat the reason stars twinkle under the rubrics of causation, metaphysical grounding, or—given that it is also idiomatic to say that movements in the intervening air *explain* why stars twinkle—'ontic explanation.'

[6] For example, Leibniz's assertion that God is the "*ultima ratio rerum*" means in part that God *creates* finite *res* (1885, VII:302). On these multiple meanings of '*ratio*' and thus of the PSR, see Schopenhauer (2012/1813, 14ff.), Carraud (2002), and Sleigh (1983, 196–97).

Yet Du Châtelet's references to truths and reasons are not idle. It is widely agreed that her PSR is more than a mere causal principle (Janik 1982; Moriarty 2006, 213; Brading 2019, 38–9). This is not because she rejects a causal principle and embraces uncaused effects in the created order. To the contrary, we've seen that she takes uncaused causes to violate the PSR. And Marcy Lascano (2011) has argued that Du Châtelet's cosmological argument for the existence of God rests on a causal principle, roughly that *ex nihilo nihil fit*.[7] So there is considerable extensional overlap, on Du Châtelet's view, between causal truths and truths that make it possible to understand why something is the case (IP II.27/ZB 144).

Nevertheless, it is significant that Du Châtelet's PSR does not explicitly mention causation. It appeals to broader criteria of understanding that are not defined in terms of causality. Room is thus left for non-causal explanation. Conversely, we'll see in section 2 that many causal propositions, on her view, fail to enable explanation or understanding. The rough idea is that if causation is understood as a sheer productive power—as merely the metaphysical ground of the "actuality" of a thing or event— then causation does not automatically enable grasping the "reasons" by which we can understand a particular state of affairs (IP I.9/ZB 131).

ii. *The ability to understand*. Du Châtelet's references to understanding, and to answering why-questions, tell us something about how she conceives of the PSR. The PSR guarantees at least the possibility of understanding. Understanding in this sense is not a mind-independent feature of the world: it is enabled by the cognitive capacities of certain kinds of subjects. But this need not make it merely subjective or up to us.

Since Du Châtelet PSR builds in a reference to the cognitive capacities of subjects, it is natural to ask which subjects it refers to. As we've seen, she sometimes connects the PSR to what *an* intelligence might be able to understand (IP I.9/ZB 131). This passage might be read as applying broadly: not just to finite minds but to the a perfect or divine intellect.

Yet Du Châtelet's discussions of the PSR single out reasons "we [*nous*]" can understand—reasons that can satisfy "us" and meet the aims of our inquiries (IP I.8/ZB 128–9). The principle is supposed to help "*us* to understand" contingent facts (IP I.10/ZB 132; emphasis added). God would not need to pose and answer contrastive why-questions, and having created the world, would not need to *discover* it through experiment and mathematical generalization (IP

[7] I leave aside how the PSR relates to human freedom. See Du Châtelet (1989), and for discussion Barber (2006/1967, 12), Moriarty (2006, 209–11), Hagengruber (2017), and Jorati (2019).

VIII.153). We can also conceive of sophisticated finite cognizers who would not seek to understand why in the way we do (Lear 1988, 3). The PSR is thus not so much essential to cognizers in general as "primitive" for beings like us: *if* a world contains such beings and is to be intelligible to them, the PSR must hold in that world (IP I.8/ZB 128; translation modified). The PSR is presumably primitive for us because of the essence of the particular kind of mind, and distinctive cognitive capacities, we instantiate.[8]

For these reasons, I take Du Châtelet's references to understanding in her discussion of the PSR to bear primarily on the capacities of finite intelligences—even if humans need not be the only such cognizers. This is arguably to the advantage of her account. If a principle of explanation such as the PSR pertains to a wider range of conceivable cognitive subjects, the explanatory consequences *for us* may be diluted or even trivialized.

This can be brought out by considering examples from Descartes and Leibniz. For these thinkers, the in-principle comprehensibility of a truth may be based solely on the conceivability of a perfect or infinite intellect's understanding the grounds of that truth. Consider Descartes' insistence that his rules of collision are a priori certainties, even though they conflict with empirical evidence.[9] Although the material world is too complex for us to fully understand, the collision rules are supposed to apply to it in principle. An infinite, perfect intellect could obtain empirically adequate results from the rules. But Descartes does not spell out how these claims about an infinite intellect bear substantively on *our* physics. Knowing that a perfect intellect could explain a given collision, for example, does not help us in grasping that explanation or applying it to actual phenomena.

Leibniz, for his part, writes in the 1710 *Theodicy* that the PSR guarantees that "there is no true statement whose reason could not be seen by one possessing all the knowledge necessary to understand it completely" (1885, VI:413–14; my translation). To the divine intellect, even miracles have lawlike explanations (1989, 48). This might seem like cold comfort, however: "most of the time," the reasons that Leibniz's PSR guarantees to exist "cannot in the least be known by us"

[8] Our cognitive constitution hardly guarantees that the world must be objectively apt for explanation by the PSR. Du Châtelet allows that it is logically and metaphysically possible (though *morally* impossible) for God to have created a world inexplicable to the minds in it (IP II.23/ZB141–2). Here one can compare Leibniz's claim that it is morally necessary—though logically and metaphysically contingent—that God creates the best possible world (1989, 195).
[9] For the *de facto* unobservability of Descartes's collision rules, see *Principles* II.34 and II.53 (1897–1919, VIII:59–60; VIII:70). On the alleged a priori justification of these rules, see *Principles* III.47, IV.203 (VIII:101–3; VIII:326), *Rules* XII (X:410–30), and *Le Monde* ch. 7 (X:46–48).

(Leibniz 1989, 217; translation modified). This again threatens to trivialize the explanatory implications of the PSR: for any given truth about the material world, Leibniz's PSR guarantees only that some reasons for it exist, not that we can ever grasp them.

If, as I've argued, Du Châtelet's PSR is largely a claim about what finite cognizers like us can understand, then it is better placed to have non-trivial implications for our account of explanation than its counterparts in Descartes and Leibniz. I turn to laying out these implications in the following section.

2. 'How and Why': The PSR as a Constraint on Good Explanations

Du Châtelet takes the PSR to help in evaluating and selecting among explanations. Her PSR can play this role because it builds in a conception of understanding that is general enough to be applied across various disciplines. In this section, I want to concentrate especially on the role the PSR is supposed to play in evaluating hypotheses. Successful hypotheses give a "*reason*" for what is observed (IP IV.56; translation modified). Thus, the important chapter of the *Institutions* on hypotheses repeatedly refers back to the PSR, and this principle has pride of place among the rules she takes to constrain hypothesis formation (IP IV.61). Now, the role of the PSR in evaluating hypotheses may seem to conflict with the idea that the principle ranges over *truths*. Hypotheses, frequently, are false. I'll examine this issue further in section 3, but it is worth noting that Du Châtelet does not seem to see a problem here. She holds that even false hypotheses can enable understanding.

Hypotheses are "probable reasons"; they are needed because even good empirical science is often far from describing the "true causes of natural effects and phenomena" (IP IV.53/ZB 147; IV.61/ZB 151).[10] Here I follow Du Châtelet in focusing on hypotheses in empirical science, particularly physics and the life sciences, though as she points out, her discussion generalizes to everyday explanations and prescriptions (IP I.8–9/ZB 128–31). Often, scientists don't yet know the laws, causes, or basic properties of given phenomena. Celestial mechanics was in this predicament prior to Newton: it was "almost impossible" for Descartes to avoid using hypotheses, for example (IP IV.55/ZB 147). In her own time, electricity and combustion provide

[10] For more on Du Châtelet's influential account of hypotheses, see Maglo (2008), Hagengruber (2012, 16–24), and Detlefsen (2017, 2019).

examples of phenomena whose basic causal "nature" and laws have not yet been identified (IP1742 XVI.399; IP VIII.163).

Du Châtelet adds we should use the general principles of our knowledge to narrow down the range of possible hypotheses. Some principles are more useful than others, however. The principle of contradiction is insufficient: it leaves "all…chimeras equally possible" (IP I.8/ZB 130). The simple causal principle that "nothing happens without a cause," while helpful, is also too broad: it does not rule out chimerical hypotheses (IP I.10/ZB 131; IP I.8/ZB 128–31). It is easy for merely speculative hypotheses to conform to this causal principle:

> any effect can be easily explained, if it is permissible to assume causes according to need, without making the effort to prove that what one supposes is not contrary to the principle of a sufficient reason. (IP1742, XVI.397)

Du Châtelet soon turns from defining the PSR to elaborating what it means for an empirical hypothesis to be contrary to this principle. Aristotelian "vegetative souls" and Cudworthian "plastic natures," she notes, have been offered as causes of various features of plants (IP I.10/ZB131). These alleged grounds are logically consistent, and *ex hypothesi* satisfy the principle that nothing happens without a cause. Moreover, they conform to versions of the PSR—which have seen a revival in the recent metaphysics literature—that merely rule out brute or ungrounded facts (Della Rocca 2010).

But Du Châtelet takes *her* PSR to give us reason to reject these hypotheses. Plastic natures and vegetative souls are not "good" (*bonne*) causes; a cause is good "only insofar as it satisfies…the principle of sufficient reason" (IP I.10/ZB 131). These hypothetical causes fail to satisfy the principle of sufficient reason because the principle builds in reference to understanding, and hence to criteria beyond the mere existence of a cause or ground for the phenomena. Positing plastic natures or vegetative souls

> does not promote understanding of why the plant that I am considering has a particular structure rather than any other, nor how this soul can give shape to a mechanism such as that of this plant. (IP I.8/ZB 132; cf. IP II.26/ZB 143–4)[11]

[11] Detlefsen (2019, 108) also notes that Du Châtelet's criticizes plastic natures and vegetative souls and calls for an "intelligible link" between the hypothesized cause and the phenomena it is supposed to explain. I take my account to complement Detlefsen's by further examining this intelligible link. In 1705, Leibniz had criticized the plastic natures of Cudworth and Grew as illegitimately circumventing mechanistic laws; see Leibniz (1885, VI:539–55) and Giglioni (1995).

The PSR demands grounds or reasons for contingent facts. Such grounds can enable understanding, through giving an account of "how and why an effect can happen" (IP I.8/ZB 131). Bringing about such an understanding of how and why phenomena take place is a crucial marker of a good causal explanation. The importance of these claims for the *Institutions* as a whole was appreciated in one of the earliest reviews of the work, from 1741. This unsigned review summarizes Du Châtelet's PSR as calling for a reason that allows one to "understand how and why" a fact is the way it is "rather than otherwise" ("*Institutions de Physique*" 1741, 301).

I take 'understanding how' to pick out the *determinate* character of good explanations, and 'understanding why' to call attention to the *contrastivity* of explanations. Du Châtelet presents these as joint conditions on good explanations: how *and* why rather than how *or* why. Yet as we'll see, these conditions can be met to varying degrees. This allows for hypotheses and theories in the history of science to be considered as relatively good explanations, even after they have been shown to be false.

I now want to explicate each of these features of good explanations in greater detail. For further clarification, I also draw connections to two other features of good explanations frequently invoked in the *Institutions*: concreteness and mathematical precision. I don't in fact take Du Châtelet to *define* either determinacy or contrastivity in terms of these further features. But if a more concrete or mathematically precise explanation is available, on her view, it will typically be more determinate and contrastive than the imprecise or merely qualitative alternatives. Mathematical precision is an especially consequential property of good explanations because it is linked both to the PSR and to our spatial and temporal way of representing the material world. For Du Châtelet, mathematical objects are in some sense "fictions," and would not figure in an ideal intellect's understanding of reality (IP V.86; V.77; Carson 2004). Yet they play a crucial role for *our* understanding.

We can distinguish two related ways that Du Châtelet spells out the notion of *understanding how*, or of what I've called the determinacy of an explanation. First, she points out that not all putatively causal hypotheses specify how the cause "operates" (*s'opère*) (IP 1.10/ZB 132). An explanatory hypothesis can specify the operation of a cause by, for example, showing how features of a plant "can be formed" (IP IV.58/ZB 149–51).

Du Châtelet goes on to invoke *mechanisms*: determinates hypotheses often specify a concrete, physically possible mechanism, even if they do not prove that the mechanism in

question actually grounds the phenomena. By contrast, it is unclear how a hypothesized plastic nature "can give shape to a mechanism [*Machine*] such as that of this plant"—that is, how the observed structure works and how it might have come about under known physical laws (IP I.10/ZB 132).[12] Du Châtelet candidly admits, however, that determinate mechanisms will not always be epistemically available. For example, it is crucial for physics to distinguish elastic from inelastic bodies. But the underlying "mechanical cause" of inelasticity is still "unknown" (IP42 IX.181).

If a hypothesis does not identify a mechanism, it may still be determinate enough to fall under a second, broader conception of understanding-how. Hypotheses may have an indispensable "practical use," and "clear the path that leads to the truth," even when they turn out false (IP IV.53/ZB 147).[13] Once a hypothesis is proposed, the next step is to deduce its consequences and test them by further observation and experiment, rejecting the hypothesis if it is contradicted by the results (IP IV.66/ZB 153). And more detailed knowledge of mechanisms will aid in designing experiments. As such, hypotheses that specify mechanisms or the operations of causes will tend to be more practically useful. There are cases, however, where experimental testing of hypotheses is possible, even though no detailed mechanism has been proposed.

Let's further consider Du Châtelet's proposal that hypotheses can play an important explanatory role even when they are false. She notes how Ptolemaic astronomy was eventually rejected, as better empirical data became available (IP IV.57/ZB 149). This process nevertheless allowed us to gain a better understanding of the solar system, and such experimental tests might never have been carried out if the Ptolemaic hypothesis had never been advanced in the first place (IP IV.57–8; V.86). Similarly, the Copernican system of the world was a fruitful hypothesis, even if its pure circular orbits and uniform speeds do not fit the facts (IP IV.71/ZB 155). This is a break with influential earlier accounts of hypotheses: Huygens (1690) notably took their explanatory power to be based on deducing true conclusions about the phenomena. In fact, for Du Châtelet, even when a false hypothesis as such provides *no* positive understanding, it can be

[12] For Du Châtelet, active and passive forces count as mechanical principles (IP VIII.145–46; IP XI.229/ZB 177). While a mechanism or *Machine* is a composite of extended parts, the *changes* in these parts are due to active and passive force (IP VIII.141).

[13] Du Châtelet's PSR has foundational practical and moral implications. It is prior to the distinction between practical and theoretical reasons or grounds (*raisons*) (IP I.11/ZB 132). So it is unsurprising that Du Châtelet's account of explanation, which is partly based on her PSR, invokes questions of "practical use."

fruitful. Given a finite number of mutually exclusive hypotheses, falsifying one of the options increases the probability of the remaining hypotheses (IP IV.57/ZB 148).

The fact that even false hypotheses can be determinate enough to enable understanding indicates that a gain in understanding-how need not require great mathematical precision. For example, Du Châtelet praises Huygens's qualitative but pathbreaking proposal that Saturn has rings (IP IV.58/ZB 150; *Exposition* 28). Earlier astronomers had offered a number of causal hypotheses to explain the phenomena—that is, Saturn's apparent changes in shape—without showing *how* Saturn might be caused to change shape so rapidly (Van Helden 1974). Huygens's (1655) ring hypothesis accounted for the observed phenomena without committing to implausible changes in Saturn's shape. And his hypothesis was determinate enough to be modeled in terms of known physical laws. In 1732, Maupertuis applied principles from hydrostatics—earlier used in determining the shape of the earth—to more precisely explain why Saturn's rings are relatively flat, and also hypothesized that the rings were formed from comets captured by Saturn's gravity (1732, 78–83). While Maupertuis's discussion appeals to known physical laws, it is clearly presented as a plausible *conjecture* about the formation of the rings, rather than as the sole account consistent with the evidence (1732, 80).[14]

So part of the value of Huygens's initial hypotheses may be that it could be developed in a more mathematically precise way. More generally, Du Châtelet holds that we should strive for mathematical precision in our hypotheses. This is how I read her contention that "according to" the PSR, effects should be "proportional to causes" (IP VIII.142). Here, 'proportional' is not just a figure of speech. If possible, the relationship between cause and effect should be specified in a mathematically precise way in order to determine the "sufficient reason" for the effect (IP VIII.142; XI.257/ZB 182). In practice, however, mathematical precision has so far been achieved only for the most simple and uniform phenomena (IP1742 XVI.399).

Mathematical precision can make a hypothesis more determinate even if that hypothesis does not aim to describe *causal* facts. Consider, for example, Kepler's rules concerning planetary orbits. Arguably, these rules are not directly causal. They describe "movements" rather than the forces that ground change in movement (IP III.65/ZB 153). Yet Du Châtelet stresses that Kepler's rules were crucial predecessors of Newton's discoveries in celestial mechanics: they are

[14] By May of 1738, Du Châtelet had a copy of Maupertuis's *Figure des Astres*, and corresponded with him about the work (Du Châtelet 2018, I.350).

mathematically precise, and enable predictions (IP IV.58/ZB 150). She also emphasizes how, although Ptolemaic astronomy has been superseded, it is permissible to use Ptolemaic assumptions to make it easier to solve certain astronomical problems. Such simplifying assumptions need not lead to error, as long as one does not take them to truly represent the world (IP IV.96; IP42 IX.183).

A subtler case is that of representations in mathematical physics that, while causally committal, are inaccurate or incomplete with respect to the causal facts in question. Du Châtelet discusses how it can be fruitful to consider, as a kind of thought experiment, a possible force of cohesion that would follow an inverse cube law (IP XVI.389). Even though no such force exists, the proposal makes precise predictions and can help us understand the actually observed forces of cohesion. Idealizations provide further examples. Du Châtelet defines "absolute gravity" as the force with which bodies *would* move in the absence of resistance (IP XVII.403). She denies that a void in fact exists; moving bodies are always in a resistant medium. Therefore, the forces bearing on bodies are only approximately or incompletely described by the inverse-square law (IP XIX.394–97). Nonetheless, the inverse-square law is of great explanatory value.

The idea that an explanation can aid in understanding even when it is silent on certain causal facts helps in interpreting Du Châtelet's complex position on Newtonian gravitation. She praises Newton's inverse-square law as "universal," precisely "demonstrated," and able to "explain" numerous phenomena (1738, 539; IP Pref.V–VI /ZB 119; IP42 XVI.388).[15] The law of gravitation plausibly aids in understanding how various phenomena take place. Nevertheless, she stresses that we do not understand how gravity itself is caused. In her view, many Newtonians were overly rash on this issue.[16] Du Châtelet takes herself to agree with Maupertuis on these issues, or so she told him in a letter of 26 June 1741. For Maupertuis, gravity is "an original fact"

[15] See also Du Châtelet (1739, 137; IP XV.344, XV.345–49) and her optimistic discussion (IP XVI.399) of Bouguer's attempts to experimentally fix what we'd now call the gravitational constant. (On these experiments, see Smallwood 2010). Such passages tell against Moriarty's (2006, 215) suggestion that for Du Châtelet, Newton's theory of gravitation is no more satisfactory an explanation than plastic natures or vegetative souls.

[16] Janiak (2018, 64–66) stresses that Du Châtelet takes aim at metaphysical "overreach" in Newtonian accounts of gravity and its grounds, even as she grants the empirical power of Newton's law of gravitation. And as Brading (2018, 165–66) explains, Du Châtelet probably held that *no* scientifically respectable hypothesis explaining the cause *of* gravity had yet been proposed. The cause of gravity is a hard empirical problem; the PSR provides general constraints rather than a detailed solution. Newton, for his part, publicly endorsed ether theories of gravity in his early career (Kollerstrom 1999). Even in 1711, he did not rule out a possible causal explanation of gravity and its laws "by the action of some subtle matter" (Newton 2004, 109).

that can ground mathematically precise accounts of the phenomena, even if the cause of gravity itself is unknown (Maupertuis 1732, 12; my translation).[17]

Du Châtelet applies this stance on explanation to many cases besides gravity. She observes, for example, that even when the causal mechanism underlying a physical property is known, the best option may be to abstract from the details of this mechanism. An engineer designing a pump ought to take it for granted that air is elastic, and abstract from the fundamental physical explanation of this elasticity (IP42 IX.181–82).

Let's turn to the *contrastive* character of explanation, which enables *understanding why* phenomena are the way they are, rather than some other way. Contrastive explanations provide what we might call modal understanding of the phenomena, beyond describing their actual causal relationships. They aid, for example, in understanding whether the same phenomena would obtain under non-actual or counterfactual circumstances—and if not, what might be different.[18] We might also be able to understand, via a contrastive explanation, why some types of event rather than others are physically possible. Identifying a cause that is sufficient for a given effect does not show that the effect counterfactually depends on that specific cause. Another way of putting the point is that our explanations should not just identify sufficient causal conditions for phenomena, but also their necessary conditions.

Plastic natures and vegetative souls illustrate how hypotheses fail to offer a contrastive explanation. On Du Châtelet's reading, these hypotheses do not "promote" contrastive "understanding of why" a plant "has a particular structure rather than any other" possibility (IP I.10/ZB 132; I.8/ZB 141; VIII.160). They do not help us understand why a given structure in the plant fulfils a role or function better than alternative possibilities.

For a more successful hypothesis, we can return to Huygens on Saturn's rings. Huygens's paper on the ring hypothesis includes a diagram of the relative positions and angles of a ringed Saturn and of the Earth. He then uses the respective positions of the planets to explain why Saturn appears a certain way to us at particular times, and not otherwise (Huygens 1659, 55). When Huygens' hypothesis was further developed in terms of hydrostatics, it provided further contrastive explanation of why Saturn's rings have the shape and composition they do. This kind

[17] See Downing (2012) for further discussion of this idea in Maupertuis.
[18] Philosophers have recently argued that contrastivity is an explanatory virtue (Lipton 2004, 71–90), or even a necessary condition on "any successful [causal] explanation" (Woodward 2003, 11).

of contrastive explanation appears to presuppose the actual physical laws—it operates, in contemporary terms, within the realm of the physically possible—rather than taking on the difficult task of contrastively explaining why a fact actually obtains rather than *any* logically conceivable alternative.[19]

Earlier, unsuccessful hypotheses had posited whatever dramatic physical changes in Saturn's shape were needed to match the planet's changing appearances. As Du Châtelet comments, there is an important sense in which these appearances "could not be explained" by earlier hypotheses, even setting aside their implausibility (*Exposition* 28). From these hypotheses, one cannot non-circularly derive the reason why Saturn appears as it does, rather than some other possibility. For the content of the hypotheses in question derives from the observed apparent changes in shape.

Huygens's proposal exemplifies how a qualitative hypothesis can be contrastive. But mathematical precision can enhance the contrastivity of an explanation by more exactly specifying the difference between actual facts and mere possibilities. Consider the case of comets. In Du Châtelet's time, it remained controversial whether gravity is the only significant or perceptible force acting on comets, or indeed whether gravity follows an inverse square law at great distances from the sun (Hughes 1988; Wilson 2016). Newton had presented powerful mathematical methods for approximating cometary trajectories from observations, but his approach was far from universally accepted. Despite her caution about the cause of gravity, Du Châtelet sides with Newton here, contending that "comets find their paths wholly mapped out by…attraction," and adding that Newton was thereby able to calculate a comet's path and make highly specific predictions (IP XVI.388). The law of gravitation not only explains why a comet follows this path rather than some other possibility, but draws this contrast with a high degree of mathematical precision.[20]

[19] This focus distinguishes Du Châtelet from earlier rationalists who linked contrastivity to the PSR. Leibniz regards reasons as contrastive, but in terms of God's *global* and mind-bogglingly complex choice of the best possible world, which is mostly inscrutable to us (1885, VI:115–16). Wolff also associates the PSR with contrastive why-questions, but specifically in the sense of explaining why *things* are *absolutely* (rather than physically) possible (1996/1726, §29; §31; §33)..

[20] As Du Châtelet notes in her later commentary on the *Principia*, a key test case was the return of Halley's comet (*Exposition* 112–14). Du Châtelet's friend and collaborator Clairaut went on to play a leading role in accurately predicting the comet's return in 1759—which indeed supported Newton's account—but she herself did not live to see this.

These examples confirm my earlier suggestion that Du Châtelet's PSR differs from a simple causal principle. For Du Châtelet, a hypothesis can satisfy a simple causal principle while failing to enable understanding 'how and why' phenomena occur (as in the case of plastic natures). Conversely, a hypothesis that does not make any explicit causal claims might be determinate and contrastive enough to satisfy the PSR (as in the case of Kepler's rules). Thus, the PSR has a different extension from a causal principle: some hypotheses satisfying a causal principle will not satisfy the PSR, while some hypotheses satisfying the PSR will not be causal.

Furthermore, a simple causal principle—such as *Nothing happens without a cause*—will not contain all the *intensional* content found in Du Châtelet's PSR. A simple causal principle makes no mention of determinacy, contrastivity, or the way in which these properties contribute to understanding. The principle that every happening has some cause does not discriminate between hypotheses that aid in understanding and those that do not. So it can be satisfied by just about any causal hypothesis. Du Châtelet's PSR contains additional content, not present in a simple causal principle, that can be used to evaluate putative causal explanations in a non-circular way.

The case of Kepler's rules suggests that Du Châtelet's PSR permits non-causal explanations. While I cannot go into details here, Hagengruber (2012, 24) discusses Du Châtelet's important claim that hypotheses play a role in pure mathematics (cf. IP IV.59/ZB 151). This may indicate that the PSR is a criterion for the explanatoriness of pure mathematical propositions. Du Châtelet also connects Fermat's Principle of Least Time—which he famously applied to the path taken by light—to the PSR (IP XVIII.471–2). She enthusiastically endorses Fermat's Principle, and stresses how it affords explanations and predictions of optical phenomena. Yet Fermat's Principle is typically not taken to be causal (Hempel 1965, 352–53).

To step back a bit to more general philosophical issues, note that Du Châtelet's conception of what she calls a 'good' explanation is not reducible to the question of how likely a hypothesis is to be true. Accordingly, I take the PSR's role in discriminating between good and bad explanations to be separable from its role in underwriting true belief. Now, Du Châtelet *does* take the PSR to bear on how likely our beliefs about the world are to be true. We can in fact assume God to have created the best possible world—a world that is, by and large, apt for explanation (IP II.26/ZB 143–44). But she is cautious in asserting that a good explanation is automatically more likely to be true. Du Châtelet does not assume we can know in any detail

what a wise God would do.[21] Instead, empirical "knowledge of causes" is our best route to discovering "the intentions and the art of the creator" (IP II.27/ZB 144; Detlefsen 2019, 121–23). In more contemporary terms, we can distinguish two projects here: that of defining what constitutes a good explanation, and that of defending the soundness of inference to the best explanation.[22] While Du Châtelet takes her PSR to be involved in both projects, she seems to recognize that they are logically independent.

By emphasizing the role of the PSR in Du Châtelet's account of good explanations, I depart from interpretations that take the primary role of this principle to lie in guaranteeing the certainty of science. Moriarty (2006, 204), for example, holds that a key role of Du Châtelet's PSR is to make "scientific laws…certain" rather than merely "probabilistic." Similarly, Reichenberger (2012, 162) contends that the PSR provides a "metaphysical…foundation for the phenomenal laws of nature." I grant that Du Châtelet's PSR is meant, in part, to increase our credence in the claims of science. But this role is limited. The following section further explores these limitations, connecting the account of the PSR laid out so far to some of the broader epistemological commitments of the *Institutions*.

3. Du Châtelet's PSR in Context: Reasoning without Certainty

I now want to briefly consider Du Châtelet's broader epistemological stance in the *Institutions*. This will clarify why she takes empirical hypotheses to be so important—and why her PSR permits even false hypotheses to have explanatory value. These epistemological commitments, in turn allow Du Châtelet's empirical use of the PSR to be historically situated with respect to figures such as Newton and Wolff. Note, however, that the claims I make in this section are basically independent of the main line of interpretation in the two previous sections. The story so far concerning the explanatory role of the PSR is compatible with various accounts

[21] Compare Chapter II of Voltaire's 1734–38 "Traité de Métaphysique," an essay written in collaboration with Du Châtelet (Voltaire 1786, XXXII:30–31).

[22] Compare what Lipton calls *Voltaire's objection* to inference to the best explanation: the goodness or 'loveliness' of an explanation is basically subjective, so unless "we inhabit the loveliest of all possible worlds," the loveliness of an explanation will not make it more likely to be true (2004, 143). Note that, as reconstructed by Lipton, Voltaire's objection does not merely target Leibniz's thesis that we live in the best possible world, but also challenges inferences from this claim to further substantive conclusions about the actual world—as when Leibniz asserts that "the truth of a hypothesis is nothing but its intelligibility" (Leibniz 1989, 91). This leaves room for Du Châtelet to agree with Leibniz that the actual world is the best, while counseling caution in inferring empirical "truth" from mere "intelligibility."

of the overall epistemology of the *Institutions*, and of Du Châtelet's relationship to her predecessors.

For Du Châtelet, our empirical knowledge is never absolutely certain. An empirical or "physical" truth is equivalent to a very well-confirmed hypothesis: it is "morally" certain but still defeasible in the face of new evidence (IP IV.67/ZB 154).[23] Du Châtelet stresses that such probable truths exert virtually the same practical "effect" "on us" as do absolutely certain claims; therefore, it is permissible for a merely probable truth to be "presented as a certainty" in many contexts (IV.67/ZB 154). Given that even the best-confirmed empirical truths differ only in degree of certainty from hypotheses, it is not surprising that Du Châtelet takes the PSR to range over possibly false hypotheses, even as she cautions against overestimating the probability of a given hypothesis (IV.62/ZB 152). So Du Châtelet does not endorse the now-popular view that understanding must be based on true belief (Hills 2016).

As such, the reference to 'truths' in Du Châtelet's PSR is best understood as ranging not just over judgments that turn out exactly true, but also over those that are held to be true with good if not indefeasible evidence. The PSR does not endow empirical claims with absolute certainty, even if it provides responses to forms of skepticism that threaten to defeat our claims to reliably grasp the empirical world.[24]

The unavailability of absolutely certain empirical truths helps explain Du Châtelet's optimism about non-deductive explanations she finds in Newton, Galileo, and others (IP X.195; XIII.300; XIV.322). For example, Newton defended extrapolating from certain types of experiment to "all bodies universally," so long as specific empirical defeaters are absent (Newton 1999, 809). Du Châtelet concludes that Newton's double pendulum experiment—in which he filled hollow pendulums with equal weights of qualitatively different materials and found their oscillations to be empirically indistinguishable—constituted "a demonstration that the quantity of proper matter of bodies is directly proportional to their weight" (IP XIV.322).[25] That is, she

[23] Descartes's *Principles* IV.205 defines moral certainty as "sufficient…for application to ordinary life" or "sufficient to regulate our conduct" (VIIIA:327; IX:323). Du Châtelet was familiar with the *Principles*. On moral certainty more broadly see e.g. Daston (1988).

[24] Brading (2019, 25–53) helpfully lays out some of the anti-skeptical implications Du Châtelet draws from the assumption that the actual world was created in accordance with the PSR; cf. Wolff (1977/1730 §77; 1720 §§142–44). As Brading also notes, even with the help of the PSR, explanations of observable phenomena from more basic principles remain *probable* rather than absolutely certain (2019, 43).

[25] See *Principia* Book 3, Props. 6–7 and for further discussion Fox (2016). Invoking his third rule of reasoning, Newton contends that since the two-pendulum experiment could be repeated for arbitrarily many kinds of matter, its results generalize, in the absence of experimentally established defeaters, to all bodies—including planets. In turn,

endorses reasoning from a series of experiments to a physical relationship that applies to "all bodies" (XIV.322). There is no indication that Du Châtelet regards the results of such reasoning as absolutely certain, even with the help of the PSR, but these results have enough support to be *treated as* certain or demonstrated for practical purposes.

Turning from certainty to some of Du Châtelet's other epistemological commitments: she holds that our grasp of created things is inevitably approximate and incomplete. It is approximate, because the empirical world is too complex for our finite capacities to fully grasp. Describing the causal history of a single body would require "becoming God" (IP VII.124; XX.540). And while a hypothesis should in principle agree with all the relevant phenomena, in practice the range of phenomena we can survey is always finite (IP IV.61).

Our understanding of created things is inevitably incomplete because of Du Châtelet's idealism about space, time, and matter. Space and time are imaginary beings that depend on our perceptual capacities. Matter, in turn, is essentially spatiotemporal.[26] Therefore, all of the essential features of matter—including matter's active and passive forces—are "phenomena" that partly depend on the mental or perceptual capacities of minds like ours (IP VIII.152–53). And it is less than absolutely necessary that minds like ours exist in the actual world. From the mind-dependence of the essence of matter, and the contingent existence of the relevant kind of mind, it follows that we cannot characterize the intrinsic essence of matter in a way that would hold for any possible world where matter is instantiated—as Descartes sought to do (1897–1919, VI:43; VII:163). That is, some essential properties of matter, as it actually exists, cannot be instantiated unless minds broadly like ours are instantiated as well.

To be sure, Du Châtelet is committed to more fundamental non-spatiotemporal substances that are causally active.[27] But we cannot observe these substances directly. Empirical

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Biener (2019, 2) argues that Newton's rules of reasoning assume "that nature is simple and orderly by divine decree"; Du Châtelet makes a similar assumption, and connects it to the PSR. There is evidence, in turn, that an unpublished early version of §10 of the *Institutions* dealt with the third rule of reasoning instead of the PSR (Barber 2006/1967, 21). The published version puts new emphasis on the PSR, but does not explicitly reject the third rule of reasoning. So there may be some overlap between the implications of Du Châtelet's PSR and those of Newton's third rule; space does not permit defending such a reading here.

[26] On the ideality of space, see IP VI.79; on time, see IP VI.99, VI.108/ZB 157–8, 160–1. At least some essential properties of body are spatial and hence ideal: shape, divisibility, impenetrability, and extension (IP VIII.137). We also find simple motion, composite motion and various physical forces defined in terms of spatial properties (IP XI.212; Chapter XII; Chapter XIII).

[27] Stan (2018) rightly stresses that Du Châtelet is not a Leibnizian *substance* idealist: she takes some of the fundamental substances that ground matter to be broadly 'physical,' rather than mind-like. Yet I cannot endorse Stan's conclusion that for Du Châtelet "the existence of bodies…does not require any mental facts to ground it"

hypotheses must be based on observable "facts" and "circumstances," so we are not in a position to make and test hypotheses concerning the fundamental substances (IP IV.61/ZB 151–2). If we combine our observations of matter with the PSR and the principle of non-contradiction, we can draw some very general conclusions about the underlying substances—notably that they lack parts and are causally active (IP VIII.155). But even with the aid of the PSR, we lack a determinate grasp of laws and essences at the level of fundamental substances. These more basic substances ground many features of bodies. So our ineluctable ignorance of fundamental substances means we will never grasp many of the reasons why bodies are the way they are.

Du Châtelet's matter idealism does not, however, shake her assurance that bodies and movement are "real" and can be "true causes," or her optimism about empirical inquiry into the material world (IP VI.104/ZB 159; IP IV.53/ZB 147; IP VI.109/ZB 161). She evidently does not take genuine scientific knowledge to require deducing phenomena from fundamental essential properties. Thus she rejects a broadly Cartesian line of foundationalist thought that is arguably echoed by Locke (Loeb 1981, 36–62; De Pierris 2015).

This moderate anti-foundationalism also contrasts with prominent claims made by Christian Wolff about the relationship between empirical science and metaphysics. Wolff's 'German Metaphysics'—a work Du Châtelet read carefully, and a clear influence on some metaphysical moves in the *Institutions*—closely links the PSR to fundamental *essences*. These essences provide the "reason" for attributes and modes; Wolff's PSR mediates between essences and their consequences (Wolff 1720, §§30–35; Dyck 2020, 101–2). Moreover, Wolff suggests that mere empirical science is not sufficient for "insight" into the essence of matter: a contentful metaphysical or 'rational' physics that employs PSR is required as well (1720, §381; Dyck 2020, 114; 1996/1726, §30). By comparison, while the PSR remains crucial in the *Institutions*, it is by and large not an independent source of substantive descriptive claims about the actual world (Brading 2019, 45). And Du Châtelet places much less weight than Wolff on the need to supplement empirical science with metaphysics in order to achieve understanding and certainty.

(493). For this neglects her view that fundamental mind-like substances—finite souls, and their representational faculties—are a *necessary though not sufficient* condition for matter as it actually exists. On souls, see e.g. IP II.21/ZB 140–1 and VII.128.

To be sure, Wolff's writings are extensive and complex, and doing them justice is beyond the scope of this paper.[28] The point I want to highlight is that in Wolff's 'German Metaphysics,' Du Châtelet would have found materials for an ambitious foundationalist project based on knowledge of essences and the PSR. It is instructive, then, that she does not appear to pursue such a project in the *Institutions*.

4. Conclusion

I have argued that Du Châtelet's Principle of Sufficient Reason is central to her account of empirical explanation. Appreciating this role for the PSR helps us see why the principle refers to the capacities of intelligent beings to understand how and why contingent truths obtain. Appreciating the principle's role in discriminating better and worse explanations also illuminates Du Châtelet's contention that hypotheses may be shown to be unexplanatory before they can be disproven. I hope to have shown that Du Châtelet's empirical employment of the PSR is coherent and philosophically defensible. I have also suggested that it represents a historically distinctive departure from the foundationalist projects of Descartes and Wolff; defending this suggestion in detail is a project for another time.[29]

[28] Paccioni (2003), Kreimendahl (2007), Vanzo (2015), Dunlop (2019), and Dyck (2021) underscore Wolff's appeals to experience and hypotheses, providing a helpful corrective to interpretations that overstress the role of formal logic and conceptual analysis in his thought. Nevertheless, Wolff takes genuine science to aim at certainty, which is achieved by deductions from real definitions that track essences (Buchenau 2011; Frketich 2019). This project can fairly be described as foundationalist—and arguably as Cartesian. Experience as inner, direct acquaintance plays an important role in Wolff's system, and his conception of metaphysics as laying out substantive, foundational principles also echoes Descartes's project—as laid our for example in the Preface to the 1647 French edition of the *Principles* (1897–1919, IXB:14–16).

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