Kant's *Transition* Project and its debt to Émilie Du Châtelet

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Abstract

In this Chapter, I shall identify relevant aspects in the *Transition from the Metaphysical Foundations of Natural Science to Physics* that can constitute Emilie du Chatelet's legacy for Kant's unpublished project. I shall show how Kant's late view of the aether – the hypostatized space understood as necessary postulate, hides a deeper meaning as explanation of the first motion of universal matter, by appealing to an original living force of impact, thereby echoing not only his pre-critical writings, but also Du Châtelet's work. More interestingly, this contribution shows that Du Châtelet exerted a greater impact on Kant's late theory of physical bodies than generally acknowledged.

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1. Introduction: How to Accomplish a Transition to Physics?

Natural sciences and their foundations constitute a guideline connecting Kant's early writings, those of the Critical period, as well as the late works. A large part of the literature focused on the role played by the *Critique of pure Reason*[1] in grounding the sciences and particularly compared the earliest with the critical writings, including the *Metaphysical Foundations of Natural Science* (1786).[2] Recent studies also made an effort in clarifying Kant's early work and its debt to scientists including Musschenbroek, 'sGravesande, de Mairan, D'Alembert, Euler

[1] References to Kant's texts follow the pagination of the Academy edition (AA). References to the *Critique of the power of Judgement* are abbreviated as KU, those to the *Opus postumum* are abbreviated as OP, whereas those to the *Critique of pure Reason* use the standard abbreviation CPR, followed by the A/B editions pagination. Translations are from the Cambridge Edition of the Works of Immanuel Kant unless stated otherwise.

[2] Friedman, M. (2013). *Kant's construction of nature: a reading of the metaphysical foundations of natural science*. Cambridge University Press; Plaass, Peter. & Weizsacker, Carl Friedrich. & Miller, Maria G., & Miller, Alfred E. (1994). *Kant's theory of natural science*. Dordrecht [The Netherlands]; Boston: Kluwer Academic; Watkins, E. (Ed.). (2001). Kant and the Sciences. Oxford University Press.

and, certainly, Emilie Du Châtelet.[3] As we shall see in this Chapter, her work still played a role in fostering Kant's reflections on the foundations of natural sciences and theory of matter in the 1790s, something that deserves our attention.

Despite the huge debate surrounding the genesis and meaning of the *Transition from the Metaphysical Foundations of Natural Science to Physics* within Kant's system,[4] we are not in a position of having fully clarified the overall scope of this unpublished monumental work. In what follows, I more modestly offer a hint on the relevance of Emilie Du Châtelet for his project. Du Châtelet's legacy in Kant's *Opus postumum* is here reconstructed with regard to four main aspects:

1) Kant's notion of "Potenz" understood in dynamical terms latches onto Du Châtelet's concept of *puissance* (without crediting her, at least in the manuscripts).
2) Kant's reference in the manuscripts to the distinction between dead and living forces and to the dispute on *vis viva* is a further hint to the fact that he considered her work in the late period.
3) The need of the geometrical foundations of physics accompanied with a suitable theory of matter and force is echoing the *Institutions de Physique* (1740) for several aspects.
4) The way in which Kant distinguishes the terms *Lichtsotff* and *Feuerstoff* as both descending from the aether is in line with Du Chatelet's conclusion set forth in her *Dissertation sur la nature et la propagation du feu* (1744).

Each of these four aspects taken alone cannot constitute and is not meant to constitute the evidence for the fact that Kant was certainly having Du Chatelet's works in mind in the late 1790s. However, the combination of them are to be interpreted, I claim, as the silent but prominent legacy of Du Châtelet's work that was widely recognized in Europe thanks to the

[3] Massimi, M. (2011). Kant's dynamical theory of matter in 1755, and its debt to speculative Newtonian experimentalism. *Studies in History and Philosophy of Science Part A*, *42*(4), 525-543. Veneroni, S. (2018). Osservazioni fisico-teoriche attorno al primo scritto di Kant sulle forze vive del 1746 (1749). LEO S. OLSCHKI EDITORE, 143. Anstey, P. R., & Vanzo, A. (2016). Early modern experimental philosophy. *A Companion to Experimental Philosophy*, 87-102. Massimi, M., & De Bianchi, S. (2013). Cartesian echoes in Kant's philosophy of nature. *Studies in History and Philosophy of Science Part A*, *44*(3), 481-49. Hagengruber, R. E. (2022). Du Châtelet, Émilie (1706–1749). In *Encyclopedia of Early Modern Philosophy and the Sciences* (pp. 510-519). Cham: Springer International Publishing. Lu-Adler, H. (2018). Between Du Châtelet's Leibniz exegesis and Kant's early philosophy: A Study of their responses to the vis viva controversy. In: *From Leibniz to Kant* (pp. 177-194). Brill mentis. Brading, K. (2019). *Émilie Du Châtelet and the foundations of physical science*. Routledge.

[4] A recent compendium to Kant's *Opus postumum* has been offered by Howard. Howard, S. (2023). *Kant's Late Philosophy of Nature: The Opus postumum*. Cambridge University Press.

dissemination of Diderot's and D'Alembert's *Encyclopedie*.[5] Furthermore, it is worth mentioning that the *Transition* project remained unpublished. Thus, we are not in a position to exclude whether Kant could have acknowledged Du Châtelet's ideas in a published edition. In the manuscripts of the *Opus postumum*, Kant seems more worried about reconstructing and offering a consistent picture of the latest scientific developments and what he considered fundamental takes on the nature of physical bodies and forces. In this regard, it is remarkable that Kant came back at the end of his life on the topics that were central in his first writings.
In the 1790s Kant's reflections were meant to open new perspectives on the interrelation of different parts of his system and on the internal transitions allowed to pass from the metaphysics of nature to physics. Kant tried to accomplish this task by providing a priori grounds to his theory of matter governed by moving forces, by showing that we can correctly pass from metaphysics to the objects of physics and unify causality in nature without falling into the dogmatic picture of external teleology or admitting a multiplicity of essences in ontology. Kant introduces a concept of transition (*Übergang*) in the *Critique of the Power of Judgement* as follows:

"Every science is of itself a system; and it is not enough that in it we build in accordance with principles and thus proceed technically; rather, in it, as a freestanding building, we must also work architectonically, and treat it not like an addition and as a part of another building, but as a whole by itself, although afterwards we can construct a **transition** from this building to the other or vice versa". (KU 05: 380-381, bold is mine)

The careful reader acquainted with Du Châtelet will immediately notice how Kant's metaphor of science as a building is close to the image adopted in her *Institutions de physique* (1740):

"Physics is an immense building that surpasses the powers of a single person. Some lay a stone there, while others build whole wings, but all must work on the solid foundations that have been *laid* for this edifice in the last century, by means of geometry and observations; still others survey the plan of the building, and I, among them" (Du Châtelet 1740, p. 12).

[5] Kant acknowledges the great value of Du Chatelet in dealing with controversies in mechanics also in 1764 (see *Beobachtungen über das Gefühl des Schönen und Erhabenen*, AA 02: 229-230).

In both Du Châtelet and Kant the analogy between the foundations of science and the architectural foundations of a building is not a superficial one. In the case of Kant at least we have evidence that this analogy is the expression of a formal part of his philosophy, i.e. the architectonic,[6] and that it follows from what he considered the secure realm of transcendental philosophy. In the case of Du Châtelet, the analogy serves to establish a hierarchy among metaphysics, physics and geometry, but at the same time to highlight the limits of current metaphysics:

"Several truths of Physics, Metaphysics, and Geometry are obviously linked to each other. Metaphysics is the pinnacle of the Building; but this peak is so high that the view often becomes a little confused" (Du Châtelet 1740, p. 14, translation is mine).

Despite of their different takes on philosophy, Du Châtelet remains one of Kant's favoured intellectuals from which he could have been inspired to handle the greatest challenge he faced on his system. Indeed, Kant was facing the challenge of filling a gap between the foundations of science outlined in the *Metaphysical Foundations of Natural Science* (1786) and the architectonic ground for the unity of the foundations of both a priori and empirical physical sciences professed in the *Critique of the power of judgement* (1790). At this point, in order to represent physics as a science and to unify phenomena under a system of moving forces, Kant restored the idea of an all-penetrating and oscillating aether meant to express the ground of a living force of impact. And it is in this context, I claim, that Du Châtelet's legacy is more prominent for Kant's work. In order to understand the relevance of such a tenet for the *Transition* project, I will now spell out the characteristics of the scientific *milieu* that led Kant to the enterprise of reshaping the relationship between metaphysics (his metaphysics of nature) and physics to be taken as a system rather than an aggregate of perceptions expressed by empirical judgments.

2. Kant's Scientific *Milieu* in the 1780s and 1790s

In order to capture the impact of Kant's *third* Critique on the genesis and development of Kant's late view of natural sciences as expressed in the *Opus postumum*, I shall now consider the epistemological and scientific questions that interested Kant in the 1790s. I shall briefly focus

[6] Indeed, in CPR A832/B860, Kant gives the following definition: "By an architectonic, I understand the art of systems. Since systematic unity is that which first makes ordinary cognition into science, i.e., makes a system out of a mere aggregate of it, architectonic is the doctrine of that which is scientific in our cognition in general."

on those pertaining to cosmology and astronomy, chemistry, biology, electricity and magnetism. From this overview, it will be made clear that the notion of aether discussed in the *Opus postumum* could have brought with it a unification of the phenomena described by these fields and could have built a bridge between philosophy and empirical sciences. In other words, it could have realized an effective transition among them in view of the unity of nature and reason, thereby embodying the architectonic function of the *Transition* project. At the same time, to deal with these topics will also explain why Kant became interested in re-exploring some old questions that engaged him in his early writings and I shall pay specific attention to some themes present in Du Châtelet's works that clearly come back in the manuscripts of the *Opus postumum*, thereby revealing the fact that she had a greater impact than generally acknowledged on Kant's work. Let us now consider Kant's late guiding questions in natural sciences. In the 1790s in the fields of cosmology and astronomy, there had been some relevant advancements that Kant took into account. Taking the cue from the works and observations of William Herschel, German astronomers such as Johann Elert Bode (1747–1826) and Johann Hieronymus Schröter (1745–1816) published a number of studies that influenced at various levels Kant's late work. The relevance of these authors emerges in the essay "On volcanoes on the Moon" (1785), in the excerpt dated 1791 of Kant's *Universal Natural History and Theory of the Heavens* and in the essay "On the influence of the Moon on the weather" (1794). Not only Kant ensured in 1791 his primacy over Lambert's nebular hypothesis, but he also tried to use chemical affinity to clarify his theory of empirical matter and the formation of Saturn's rings. In the early 1790s, thus, we find evidence that Kant tried to apply chemistry to astronomy and that he still holds to be true his theory of a hierarchical and systematic order of the universe. In order to encompass these aspects within his system by grounding them on solid principles of reason resulting from the resolution of the antinomy of pure reason, he still holds that matter is indefinitely divisible (intensively, according to quality) and that the beginning in space and time of the universe is spatially and temporally indefinite (cosmological principle of reason). These two tenets become even more important in the manuscript of the *Opus postumum* when Kant will address again the problem of the beginning of the motion of the universe, by giving an answer in line with Du Châtelet's arguments for living forces spelled out in Chapter 21 of her *Institutions du Physique* (see Sections 3 and 4 below). The reasons for Kant's re-exploration of her work must be sought in his increasing interest for the new chemistry of Lavoisier and the elaboration of a system of moving forces that could accommodate also biology and chemistry within the unitary picture of physics. In the 1780s, chemistry is still defined by Kant as an improper, albeit rational, science that studies the

changes of matter into new kinds and it is clearly distinguished from physics. The chemistry to which Kant confers this status is the Phlogiston chemistry of Georg Stahl. We have evidence that Kant clearly distinguishes physics from chemistry even in the 1794 essay "On the influence of the Moon on the weather" (see also McNulty 2017 and De Bianchi 2018). In the *Opus Postumum*, Kant endorses a conception of chemistry as "the science of inner forces of matter" (OP 21:453). It is not surprise then that in the *Opus postumum* we repeatedly find the reference to living forces, since not only Du Châtelet but also Kant discussed them with reference to debates on the intension of bodies and the forces associated with them. In particular, in the second half of the 1790s, Kant endorses Antoine Lavoisier's theory of elements, oxygen theory of combustion, and gives a central role to the caloric (see McNulty 2016). Thus, considering Kant's architectonic view of interrelation among the sciences, one can see that he was looking for a bridge to be built not only between metaphysics and physics, but also between chemistry and physics, so that the unity of the latter could have had guaranteed the architectonic unity of physics in general by filling a gap between a priori and empirical principles of human faculties. The hypothesis of the caloric is thus eminently playing a unificatory and architectonic role in Kant's late writings. Further theoretical development of this unificatory role consisted in attempting the construction of an *a priori* proof for the existence of the aether. The literature distinguishes the two phases: in the first versions of the *Transition* project (1796-1798), Kant talks about the caloric and we do not find the postulate of the aether and the a priori proof of its existence that is rather sketched in between 1798-1799. However, I argue, both were the result of the architectonic function that guided Kant in developing his system.

And now we enter into the discussion of a further element that corroborates the idea that the architectonic nature of the *Transition* project led Kant to reflect again upon living forces and the necessity of clearly distinguishing them from the concept of vital force. I am referring to biology and the debates on organisms that Kant had in mind in the 1790s. The literature mainly focused on reconstructing the relation of Kant's *third* Critique to the work of Johann Friedrich Blumenbach (1752 – 1840), concluding that Kant remained more ambivalent than has frequently been contended (Zammito 2007; Zammito 2016; Huneman 2007) with respect to his theory of epigenesis and that the convergence of their views was overestimated by themselves. However, as a matter of fact, the theory of epigenesis was central to the discussion of natural generation in the eighteenth century and it is discussed in the *third* Critique. According to Zammito (2007), Kant was never fully comfortable with the idea of epigenesis and had a problematic relationship to that theory. The reason for that is the following: in the late 18th

century, epigenesis was a theory of generation endorsed by proponents of hylozoism. The latter was one of the expressions of what Kant called '*Schwärmerei'* and fiercely opposed in his works (see also De Bianchi 2021). For Kant the very idea of encompassing metaphysics, physics and biology by ascribing intelligence or spontaneity to matter by means of vital force (*Lebenskraft*) has to be completely rejected. However, an alternative proposal to unify the laws of nature must have been provided to explain the generative driving force of life. Kant's answer in the *Critique of the Power of Judgment* results from the resolution of the antinomy of teleological judgment and in appealing to the concept of the technique of nature as internal ground of generation. The concept of the technique of nature is an internal ground for all generation and it must be thought of in analogy with the idea of an architect that designs living things. However, this generative ground does not reside out of nature but within it and Kant understood it as a purely epistemic tool through which we can limit the reflective power of judgment when studying organisms and judging nature as a system. However, in the *Opus postumum*, precisely because this kind of judgments could obtain only a regulative function, Kant offered a systematization of elementary forces that included the organic ones, thereby abandoning the concept of the technique of nature and looking for an objective systematization and unification of natural products, which just like other bodies, were constituted by matter.

Let me add to this, that in the 1790s not only organic forces, but also electricity and magnetism were in need of a unitary explanation. Mostly influenced by the works of Franz Ulrich Theodor Aepinus (1724 – 1802) and Georg Christoph Lichtenberg (1742 – 1799), in the 1790s Kant considered the phenomena of magnetism and electricity to be unified under a unique system of moving forces of matter. In other words, positive and negative poles were nothing else but expression of the action of more fundamental forces of attraction and repulsion. This topic is also central in the manuscripts of the *Opus postumum* and is strictly related to Kant's reflection upon the forces of matter. It is worth noting, however, that whereas organic forces were considered primitive ones, electric and magnetic phenomena were only derivative of attraction and repulsion and were in fact subsumed under them. To sum up, in the 1790s natural scientists pursued the most speculative hypotheses appearing in the second edition of Newton's *Opticks* (mostly in Query 31) focusing on the properties that could be considered inherent to particulate matter. Natural scientists proposed to study attraction and repulsion in chemical and electrical phenomena, in such a way that the notion of inert matter seemed to be entirely inadequate, and the inquiry shifted from mathematical kinematics to "experimental physics" and "natural history", addressing the problems of "imponderable fluids," such as electricity, magnetism,

chemical bonding, light, and heat, on the one hand, and the problems of "organized form" or life, on the other. This brief overview immediately displays us something that cannot but attract our attention. What could possibly be a common ground internal to nature to unify the system of moving forces of matter? In order to provide an answer to these questions it is fundamental to refer to Emilie Du Châtelet, whose ideas played a greater role than commonly acknowledged in Kant's late reflections.

3. Kant's *Transition* Project: Back to Du Châtelet

In the *Opus postumum*, Kant thoroughly discussed the concept of living force (*Lebendige Kraft*, see OP 21: 378-379; 22: 189; 272; 312; 602; 604; 612) in order to describe how motion began in our universe and to explain phenomena of rarefaction; thus, he clearly separated its meaning from the concept of vital force (*Lebenskraft*) in order to offer an alternative view to rational theology and hylozoism. This move is accompanied by the explicit mention of the *vis viva* dispute:

"Repulsion (repulsio) is either pressure (preßio) or shock (ictus) initium contactus. The former is dead, the latter is living force (not vital force vis vitae). The estimation of living forces according to the square of the velocity has caused controversies ="[7] (OP 21:105, translation is mine)

In the 1790s, Kant still distinguished between dead force of pressure and the living force of impact or shock (*ictus*) to define the content of the concept of repulsion. Now, it is worth noting that both are connotating repulsion, the force responsible for rarefaction. In the various versions of the *System of moving forces* appearing in the *Opus postumum*, Kant denotes attraction and repulsion as primary forces. Thus, the force of repulsion determines a priori the concept of physical matter and in turn can act as either dead or living force, whereas attraction is responsible for cohesion and the physics of ponderable bodies. Leibniz must be credited for the distinction between dead and living forces, but it is the Marquise Du Châtelet that recognized the value of this distinction in her dispute with de Mairan, and Kant acknowledged this in his *Thoughts on the true estimation of living forces*.[8] Du Châtelet talked about the distinction between dead forces (*forces mortes*) and equilibrium of powers (*equilibrium des puissances*) in Chapter 20 of her *Institutions du Physique*. She defined dead force or virtual

[7] The original reads: "Die Abstoßung (repulsio) ist entweder Druck (preßio) oder Stoß (ictus) initium contactus. Jene ist todte, diese ist lebendige Kraft (nicht Lebenskraft vis vitae). Die Schätzung der lebendigen Kräfte nach dem qvadrat der Geschwindigkeit hat Streitigkeiten erregt ="

[8] See Massimi and De Bianchi (2013).

force (*Force morte ou Force virtuelle*), as a simple tendency to motion. On the contrary, living force (*force vive*) pertains to a body in an actual motion. Moreover, for Du Châtelet, like Kant, dead forces are dubbed "pressing forces" (*Forces pressantes*), because they press the bodies that resist them, and they are an effort to disturb them from their position. The measure of dead force is the product of the mass times the initial velocity. In Chapter 21, titled *De la Force des Corps*, Du Châtelet begins by stating that "A body cannot pass suddenly from motion to rest, nor from rest to motion." Then it goes on to affirm that "all mathematicians agree on this principle, they always measure the ratio of efforts or dead forces by the products of the masses multiplied by the initial velocities, and no one has ever thought of calling this truth into doubt; but it is not the same with *vis viva*, that is to say, with the force which resides in a body which is in an actual motion, and which has a finite speed, that is to say, say, a speed infinitely greater than this initial speed of which I have just spoken." And it is in this context that Du Châtelet credits Leibniz for discovering "the true measure of *vis viva* and for distinguishing the two forces." What is then the difference between her and Kant's take on forces? On the ground of the latest developments of chemistry in the 1790s, Kant associated to the primary force of repulsion the phenomenology of rarefaction. The latter has been treated by Du Châtelet, but only mechanically, as diminution in the density of something, and metaphysically she considered it as direct consequence of Fire (see Du Châtelet 1744, p. 48). Kant is here merging Du Chatelet's mechanical explanation of rarefaction and his metaphysical concept of repulsive force: the latter is the ground of the former in view of the unity of experience. Indeed, things become more interesting in the face of the further determination of Kant's concept of primary motive forces: both are the determination of the concept of moving matter, but in order to unify perception (intensive magnitude of space and time) and physical phenomena, Kant refers to the notion of the aether (*Wärmerstoff*) as hypostatized space. The latter permeates everything in the universe, including physical bodies and it is the *substratum* to which the forces of attraction and repulsion pertain. Furthermore, it is the ground of the power (*Potenz*) of the moving forces:

"The fact that the ponderosity of matter is not in the same proportion with its cohesibility (e.g. lead and iron, copper and tin, etc.) may perhaps be due to the different compositions of the elemental light with the elemental heat, which are both subject to the **dynamic power** of the caloric (aether), but for their difference we cannot provide sufficiently clear concepts; because they are perhaps matters united in

electricity and separated in explosion in which the species of air dissolve in order to disperse their elements separately in space".[9] (OP 21:515, translation is mine; bold is mine)

Whereas the former concepts of dead and living forces, as well as the mention of the *vis viva* controversy, do not necessarily hint to an impact of Du Châtelet's work on the late Kant, this passage leads us to consider the notion of "Potenz" as the correlate of the term "puissance" used by Emilie Du Chatelet to explain the ground of living forces. Moreover, the passage clearly maintains the distinction between *Lichtstoff* and *Feuerstoff* as is clearly found also in Du Chatelet's *Dissertation*:

"I conclude from everything I said in this first part.

1. That light and heat are two very different effects and very independent of each other, and that they are two ways of being, two modes, of the being that we call Fire.

2. That the most universal effect of this being, the one that it operates in all bodies, and in all places, is to rarefy bodies, to increase their volume, and to separate them down to their elementary parts when its action is continuous". (Du Châtelet 1744, pp. 48-49, translation is mine)

Du Châtelet's presence becomes more tangible when we consider how Kant not only comes back to the discussion of living forces, but also how he connects the discussion of a living force of impact to his cosmology:

To assume such a matter (caloric) filling cosmic space is an inevitably necessary hypothesis, for, without it no cohesion, which is necessary for the formation of physical body, can be thought. All matter, however, is originally combined in a whole of world-attraction through universal gravitation, and thus the aether itself would, however far it may extend, be in a state of compression, even in the absence of all other matter. Such compression must however be oscillating because the first effect of this attraction in the beginning of all things must be a compression of all its parts toward midpoint, with consequential expansion, and which because of the elasticity of the world matter, must hence be set in continuous and everlasting oscillation. The secondary matter distributed in the aether is thereby necessitated to unify itself into bodies at certain points and so to form cosmic bodies. This universal attraction, which the matter of the aether exerts upon itself must be thought of as a limited space (a sphere), consequently as the one universal cosmic body, which compresses itself in a certain degree though this attraction. It must, however, be regarded, just in virtue of this original compression and expansion as eternally

[9] The original reads: "Daß die Ponderosität der Materie mit der Cohäsibilität nicht in gleichem Verhältnis steht (z. B. Bley und Eisen, Kupfer und Zinn, etc.) mag vielleicht von den Verschiedenen Zusammensetzungen des Lichtstoffs mit dem Feuerstoff, die beyde unter der dynamischen Potenz des Wärmestoffs (Aethers) stehen, herrühren von deren Unterschied wir uns aber nicht hinlänglich klare Begriffe machen können; weil sie vielleicht in der Electricität vereinigte und in der Explosion sich trennende Materien sind in welche die Luftarten sich auflösen um ihre Elemente im Raume abgesondert zu zerstreuen".

oscillating and hence all cohesion can only have been produced (or be produced further) by the living force of impact, not the dead force of pressure (OP 21: 378-379).

Here Kant rephrases what Du Châtelet also discussed in Chapter 21 of her *Institutions du physique* (Section 588), where she clearly states that "living forces are the source of motion in the universe",[10] and he also echoes the conclusion she had drawn in the *Dissertation*: "One of the distinctive and inseparable properties of Fire is therefore to be equally spread throughout space, without any regard to the bodies which fill it, and to tend to re-establish the balance of heat between bodies, as soon as the cause who broke it comes to an end" (Du Châtelet 1744, p. 47, translation is mine). Furthermore, Du Châtelet explicitly supported the possibility that the aether was responsible for Newtonian universal attraction and gravitation:

"It remains to be examined if some subtle matter is not the cause of this phenomenon [...]; perhaps a time will come when we will explain in detail the directions, movements, and combinations of fluids that operate the phenomena that the Newtonians explain by attraction, and that is an investigation with which the physicians must occupy themselves". (Du Châtelet 1740, p. 334)

Thus, at the end of his life Kant explicitly goes back to Du Châtelet's arguments and uses them to address the relevant questions of his late cosmological perspective. Whereas for Du Châtelet one cannot admit the aether without experimental evidence, Kant tries to provide a philosophical proof of its existence. The aether is something immaterial, a postulate in view of the unity of experience as a whole: something that humans never fully achieve but must think of to satisfy the need of pure reason and realize themselves as *cosmotheoroi* and intelligence (see OP 21:31). The ground of the motive forces of matter is internal to the system of transcendental philosophy[11] and within the universe itself, i.e. within matter constituting physical bodies. No external forces nor supreme will, e.g., God, could act upon space and matter. In the 1790s, Kant is endorsing a position present in his early writings on natural science and is confirming his endorsement of a notion of living force that latches onto Du Châtelet's. However, differently from the 1740s, the late Kant could count on a system of general logic and transcendental philosophy which inevitably marked a difference with the metaphysical debates in the 1730s and 1740s, which shaped Du Châtelet's and the young Kant's arguments.

[10] Another relevant passage is in Section 525 (Du Châtelet 1740, p. 401): "Toute Force motrice produit une pression; mais la pression de la force morte est détruite à tout moment; & celle de la force vive ne l'est pas."
[11] A similar take to denote internal teleology is deployed by Kant in the *third* Critique when dealing with the concept of the technique of nature, see De Bianchi (2011).

Furthermore, it is worth noting that in the *Opus postumum*, Kant makes the link with the concept of transition spelled out in the third Critique and its teleological stance explicit. Indeed, for Kant the transition from the metaphysical foundations of natural science to physics is accomplished thanks to the system of moving forces. The latter is what he calls "an intermediate concept" (*Mittelbegriff)* that pertains to both sciences: metaphysics and physics (see OP 21:478). More interestingly, Kant portrays the transition from one to the other as a tendency (*Tendenz*) inherent to the system of knowledge itself (see OP 21: 478; 482):

But the tendency in the transition from metaphysics to physics cannot be immediately satisfied with a leap. For those concepts, which lead across from a system of one sort to another, must be accompanied by empirical principles as well as principles a priori. The former, since they contain comparative universality, can, like the wholly universal, be used for the system of physics. Thus, there is a gap to be filled between the metaphysical foundations of natural science and physics; its filling is called a transition from the one to the other.

1. The moving forces of matter according to the quantity of matter, and summa according to the categories

2. The formal conditions of this motion insofar as it rests on principles a priori

Attraction – repulsion

Ponderable – imponderable

Coercible – incoercible/

Subsistent in space – or inherent" (OP 21:482-483)

Now, whereas the concept of moving forces pertains to both territories it alone cannot ground the unity of the *System of the World*, which was meant to be the second part of the *Transition* project. What is needed for this second step is the postulation of the aether that guarantees the continuity of matter, or even better the continuity of the degree or perception in our experience as effect of impact due to oscillation and vibration of the aether (OP 21: 309-310). Interestingly, the ether is not secondary physical matter that we can directly experience, but is a postulate and therefore something immaterial, but at the same time it is the ground[12] of motive forces

[12] The aether is portrayed by Kant as a sort of receptacle making the power of living forces possible. Whereas this interpretation could lead and led scholars to suggest an analogy between Plato's chôra, discussed in the *Timaeus*, and Kant's aether, I want to stress here that Du Châtelet explicitly associated the Fire to the notion of *anima mundi*

(see OP 21:221-222) and it must also be seen as a physical explanation for the universal dynamics of the cosmos:

"By the concept of caloric, I understand a universally distributed, all-penetrating matter, internally uniformly moving in all its parts, and remaining permanently in this state of internal motion (agitation). It forms an absolute, self-subsistent whole, which as elementary material, both occupies (occupans) and fills (replens) cosmic space. The parts of it, continuously agitating one another in their place (and hence not locomotively, but concussively - not progressively) and ceaselessly agitating other bodies, preserve the system in constant motion and contain the moving forces as an outer sense-object. This matter is also, as a consequence of the aforementioned attributed, negatively characterized: as imponderable, incoercible, incoesible, inexhaustible; for the contrary characterization would conflict with those attributes. Ponderability, coercibility, cohesion and exhaustibility presuppose moving forces which act in opposition to the latter and cancel their effect." (OP 22:609-610)

This characterization of the cosmic aether as an "in-between" the intelligible and the sensible addresses the problem of the generation of the universe in that it is inextricably linked to the hypothesis of the original force of impact responsible for the expansion and the growth of the cosmos from within. This postulate is fundamental for both the physical and conceptual transition to occur, namely Kant thought of it as being both something indirectly testable (via experiments and observations) and conceptually indispensable to think of the passage from metaphysics to physics.

4. Kant and Du Châtelet on the Geometrization of Physics: Space, Time and *Positus*

From what has been discussed in the previous sections, in the *Opus postumum*, the general concept of transition is schematized through a synthesis applied to the pure form of space and gives rise to the postulate of the aether that allows to pass from one science to another of a system according to ends of reason. Indeed, when Kant continuously refers to the aether as what allows "experience in general," he is referring to a postulate but also to an idea of reason as hypostatized space that allows the metaphysics of nature to have physics as its end. Now, this move implies that not only a new schematism is needed, but it must also be connected to a different horizon, namely a brand-new system of transcendental ideas must be associated to the products of this schematism. This new system of ideas is that of God, World and Man in

in her *Dissertation* (see Du Châtelet 1744, p. 48). I am not dealing with this aspect here, but it is worth further investigating the impact of Plato and Platonism on both Du Châtelet and Kant in future studies.

the World (*Cosmotheoros*) presented in the late manuscripts (1799-1801). The new schematism that Kant has in mind is an indirect one, it does not operate on a particular manifold given in intuition, but on forms of intuition themselves e.g., space and general concepts such as that of cause, generating the concept of moving forces of matter (see OP 21:525-526), in other words, it is a schematism of forms and relations. This explains why the *Opus postumum* is replete with the discussion of the forms of intuition space and time together with *positus* (e.g. OP 22:68; 22:450-451; 22:504).[13] For instance Kant states:

"Time has no duration. Its being (now, future, at the same time, before, after) is a moment. Continguity and juxtaposition are positus (places) in space."[14] (OP 22:05, translation is mine)

But what do *places* mean in this context? In order to answer, I suggest to consider, once again, Du Châtelet's *Institutions du Physique*. In Chapter 5, she devoted her investigation to the concept of space and added an important section discussing the notions of place (*place*) and situation (*lieux*, *loci*). In the first case, she claims: "We call place, the assembly of several sites, that is to say all the sites of the parts of a body taken together" (1740, p. 111).[15] Du Châtelet also argues that in place all parts of a body must exist together, or at least should be considered as such, whereas situation is described as follows:

"Finally, we call situation the order that several non-contiguous beings follow in their coexistence, so that taking one of them for the first, we give a situation to the others who are far from it with respect to that one […]. Two things therefore have the same situation with respect to a third when they are at the same distance; it is for this reason that we say that all the points of a circumference have the same situation with respect to the center, insofar as we can put the same extent between two". (Du Châtelet 1740, pp. 111-112, translation is mine)

Thus, on the one hand, Du Châtelet's notion of place embodies a property typical of geometrical objects consisting in a part-whole relationship implying coexistence. On the other hand, the notion of situation includes a network of events or points to be reciprocally related, thereby generating an order of coexistence, identifying a position. These spatial notions are embedded

[13] See Kant OP 22:68: "Spatium, Tempus, Positus sind nicht Objecte der Anschauung sondern selbst Anschauungsformen die a priori synthetisch aus dem Erkentnisvermögen hervorgehen". In OP 22:05 the reference to Du Châtelet is even more evident, because Kant reports the same example given in the *Institutions du physique* (see Du Châtelet 1740, pp. 111-112).

[14] The original reads: "Die Zeit hat keine Dauer. Ihr Seyn (jetzt, künftig, zugleich, vordem, nachdem) ist ein Augenblik. Das Nebeneinander u. außer einander sind positus (Stellen) im Raum".

[15] The original passage reads: "On appele place, l'assemblage de plusieurs lieux, c'est-à-dire tous les lieux des parties d'un Corps pris ensemble: ainsi, nous disons, la place d'un livre dans une bibliotheque d'où on le tire, parce que nous voyons que dans cette place toutes les parties de ce livre y peuvent exister ensemble; & nous disons: il n'y a pas assez de place pour ce livre, lorsque nous voyons que quelques parties de ce livre seulement y pourroient exister ensemble".

in Kant's definition of *places* (*positus*), which assumes the relevant function of grounding the application of mathematics to physical phenomena by means of primary geometrical elements[16] to calculate the internal motion of the universal matter, i.e. the aether. Consider the following passage:

"The transition from the Metaphysical Foundations of Natural Science to Physics is a special science of the moving forces in nature insofar as they could be seen a priori as belonging to the form of its relationships and connections and could constitute a system. Of friction as a resistance in the displacement of rigid surfaces pressed against each other. […] All contact is repulsion. The origin of repulsion is impact. The repulsion which continuously changes with the attraction of matter, is the oscillatory motion (motus tremulus, oscillatio interna). This, as the movement of an original fluid matter, is the aether. The mathematical expression for contact is the position (positus) of a straight line or of a flat surface in so far as it has only one point in common with a curved one (angulus planus or also solidus). When the compound angle is equal on both or all sides, the figure of the surface or body touched is a circle or sphere. The attraction that springs out from this figure is the physical contact that is only possible through the living force of concussion." (OP 22:504, translation is mine)

This passage contains important information: Kant believed that the schematism of the transition was from metaphysics in view of physics as its end (OP 21:289; OP 22:166, 21:289) and for the possible use of pure theoretical reason, which is always empirical, thus it must include the form of *positus* understood as situation, namely it must include not only space and time, but also the form of intuition of the condition for the spatio-temporal relation among points or events to measure them, namely *positus* is the condition for establishing invariance, i.e. distance, in an Euclidean metric. Furthermore, only spatio-temporal situations as a sort of a priori intuition can guarantee the correct application of mathematics and the true estimation of the moving forces (living forces) of the aether describing its internal oscillation. In this sense the *Transition* project accomplishes Kant's reflection upon the notion of "Übergang" as a key to develop an architectonic of reason in the 1790s and explicitly focuses on the use of reason that purposively uses physics to give effective meaning to the metaphysics of nature. However, metaphysics also gains meaning in teleological terms namely it is in view of physics, its scope is to ground the latter, just as transcendental philosophy is meant to have as end the constitution of the metaphysics of nature and the metaphysics of morals. In analogy with architecture, we can thus identify the schematism of transition as a functional connector. The domains to be connected in the *Opus postumum* are those of the metaphysics of nature and physics, i.e. the a

[16] In OP 22:534 Kant refers to "Elementa primi ordinis primitiva" which generally correspond to points, line, and plane in Euclidean geometry, in order to define the "Urstoffe" (he denotes them as στοιχεια), namely in order to define the specific difference of the material manifolds according to the function of quality.

priori principles spelling out the properties of matter, understood as a concept of reason, and the properties of continuous matter, understood as a result of a mathematical construction. In other words, the postulate of the aether is not only meant to unify and explain the system of moving forces, but also what Kant calls the 'System of the World'. Indeed, when representing the unity of the universe as an oscillating whole, the concept of an all-pervading subtle matter is nothing else but an unconditioned that serves to unify the system of moving forces and even to allow the transition among them, e.g. from repulsive to organic forces; but at the same time the aether is a virtual *substratum* (hypostatized space) through which we can justify singular experiences (the phenomenology of compression, contact etc.), relate spatio-temporal events as *loci* to calculate lengths, i.e. distances, and to measure motive forces, i.e. attraction and repulsion, as well as the geometry associated to hypostatized space (sphere in 3D, circle in 2D). More importantly, the a priori proof of the existence of aether was needed to allow the transition from the *System of Elements* or elementary system of moving forces to the *System of the World*: the aether possesses an architectonic function and this aspect determines a new step in Kant's philosophical reflection. Furthermore, since technically only a transition from a science to another is allowed, this is consistent with what Kant repeatedly states in the *Opus postumum*, namely we are entitled of talking about a transition from metaphysics to physics, only if the latter is a system and not a mere aggregate. But, since physics includes astronomy and observational cosmology, it must also provide an architectonic ground to think of the universe as a system and without generating dilemmas. Thus, to rephrase the entire system of transcendental philosophy and to rethink concepts of reason and the role of the understanding within this new framework was really a tantalic effort and it is no surprise that Kant could never accomplish it.

5. Concluding Remarks

In this Chapter, I underlined relevant aspects that can lead us to read Kant's *Transition* project in continuity with the legacy of Emilie Du Châtelet, with emphasis on her theory of matter, living force and gravitation. Kant shared with her the idea that we cannot predicate anything with regard to the origin of the universe as a whole, but we must assume that its existence was already given, albeit in an indeterminate form, and then only ask about the original force that set out matter into motion. Another relevant point of convergence between Kant and Du Châtelet consists in having introduced together with time and space also an a priori form of

relational spatio-temporal intuition (*positus*), capable of grounding the geometrization of matter. Even if Kant never published the *Transition from the Metaphysical Foundations of Natural Science to Physics*, and his attempt remained hidden or disclosed to very few scholars for more than 120 years, Kant was engaged in finding the *a priori* ground for the architectonic concept of matter in the aether, which in turn he thought as being responsible for phenomena that were experimentally testable. For this reason, Kant's late ontology and epistemology could be embodied in the revised version of the scholastic dictum "Forma dat esse rei", if and only if we assume that reason and senses constitute the whole of the conditions for possible experience and from an architectonic perspective the essence of things is the formal or the ideal that we inject with purpose in the world:

"Forma dat esse rei. For the essence of the matter can only be known through reason; but now all matter of knowledge must be given through the senses; therefore, the essence of things, insofar as they are known through reason, is form." (*Refl.* 3850, AA 17:310, translation is mine)[17]

Thus, thanks to this architectonic stance, Kant assumed, in line with the epistemic stances of the *third* Critique, an internal ground for the motive force setting up the whole universe into motion and identified this ground with the original moving force of impact, which is living force. After more than 50 years from his thesis *Thoughts on the true estimation of living forces* and his first encounter with Du Châtelet's work, Kant came back to the very same origin of his monumental philosophical reflection and undoubtedly Du Châtelet must be listed among the top scientists and philosophers who had a huge impact on Kant's transcendental philosophy, thus far beyond the pre-critical period.

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[17] The original reads: "forma dat esse rei. Denn das Wesentliche der Sache kan nur durch Vernunft erkannt werden; nun aber muß alle Materie der Erkentnis durch Sinne gegeben seyn; also ist das Wesen der Sachen, so fern sie durch Vernunft erkannt werden, die Form."

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