Chapter 7: Finitism in the Metaphysical Foundations

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1. Introduction

Recent readings of Kant's *Metaphysical Foundations of Natural Science* begin with the claim that Kant presents a *theory* of matter, and of the interactions between material substances, in that work. Emphasizing this point raises a question that comes up in interpretations of the *Metaphysical Foundations* more generally: what is more fundamental to Kant's account of matter? A description of how law-governed interactions are explained as arising from the essential properties and powers of objects (the Necessitation Account)? Or an account of how we come to know universal laws of nature via formal inferences regarding the a priori foundations of particular empirical laws (the Derivation Account)? Or a Best System Interpretation (BSI), on which "the particular laws of nature are those empirical generalizations that would figure in the best systematization of the empirical data at the ideal end of inquiry" (Breitenbach 2018, 111)?

I have argued (Patton 2017) that Kant espouses an "essentialist" view, and that a complete exposition of the "real essences" of material bodies is necessary to Kant's argument in the *Metaphysical Foundations of Natural Science*. Thus I have defended a version of the Necessitation Account (NA), which is the first view above: that "empirical laws are necessary governing principles that obtain by virtue of the particular natures of things."[1]

In this paper, building on recent and longstanding work (Warren 2001, Friedman 2013, Glezer 2018), I investigate how the account of the essences or natures of material substances in the *Metaphysical Foundations* is related to Kant's demand for the completeness of the system of nature. We must ascribe causal powers to material substances for the properties of those substances to be observable and knowable.

[1] Breitenbach (2018, 111–12). See Kreines (2017) for the original classification of Kantian accounts in this way.

But defining those causal powers requires admitting laws of nature, taken as axioms or principles of natural science, which govern anything that can be constructed mathematically or "given as an object of experience" (MAN, 4:474–75).

Presenting a complete system of nature requires adumbrating the properties of material substances that can be objects of experience. But it is not possible to show how those properties are involved in explanations of the phenomena without involving the laws that govern interactions between material substances. And the enumeration of the comparatively inner properties of material substances[2] requires appeal to how they would interact with other substances. For Kant, or so I will argue, it is not possible to account for the natures of things, or for the features of laws of nature, independently of each other.

The account presented here thus may seem at first to push in the direction of a Best System Interpretation, on which "the systematic unity of our cognitions of nature… confers the status of a necessary law on empirical regularities."[3] But instead, my account is intended to substantiate a fourth reading of Kant on laws: the **Finitist Account (FA)**.[4] The Finitist Account has it that modal judgments about the possible proofs that can be made, or interactions that can be explained, are (1) based on concrete intuitive reasoning and motivated by the desire to avoid appeal to the actual infinite, (2) grounded in finite decision procedures, which are (3) based on reliable systems of axioms or rules of inference.

The difference between the Best System Interpretation and the Finitist Account may seem small at first. According to the BSI, "systematic unity is… constitutive of the necessity [of] and our knowledge of the laws" (Breitenbach 2018, 111). Thus, for the BSI, systematic unity has an independent role to play in Kant's justification of the laws of nature.

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[2] This terminology is due to Warren (2001, 47).

[3] Breitenbach (2018, 111). The BSI was inaugurated by David Lewis in general, and by Philip Kitcher in Kant's case. It is notable that a version of the BSI has been defended by Michela Massimi as her own position on the laws of nature (2018a), while in Kant's case in particular Massimi defends a version of 'dispositional essentialism' (2017a).

[4] For a reading of Kant as a finitist about arithmetic, see Tait (2016) and the response from Sieg (2016).

The Finitist Account links Kant's "ontological commitments" regarding matter to his account of the system of nature that can be constructed in concert with an account of matter as phenomenal substance.[5] The role of laws of nature in finitist accounts is regulative, and it is relative to our capacity to analyze substances using mathematical principles, and to demonstrate that such substances can be objects of a possible experience. Matter can be defined as a phenomenal substance with certain properties and powers only insofar as two conditions are met jointly: (1) that we can show how those powers and properties interact with the formal requirements of our system of laws, and (2) that we can show that all possible events that can be objects of experience will fall under that system. Kant does not appeal to a "systematic unity" governed by a priori laws at the ideal end of inquiry, but rather to our ability to integrate any proposed feature of matter into the system of nature, considered as a nexus of phenomenal substances.

In Section II of the paper, I will explain how the exposition of the concept of matter features in Kant's argument for the physical completeness of the system of nature. Kant's system of nature can be built, as section IV will discuss, without appeal to actual infinity or to divine intervention. Section III deals with two key positions of the MAN: (A) that judgments about the possible motions and interactions of material substances based on the a priori concept of matter are synthetic, and (B) that we may argue for the observability and reality of matter based on its causal powers. Section IV lays out the case that Kant's reasoning in the MAN is finitist and argues that the NA can be consistent with the FA.

2. Completeness and the Exposition of Concepts

Part of the goal of the *Metaphysical Foundations of Natural Science* is to demonstrate the *completeness* of the metaphysics of corporeal nature. In order to do so, it is necessary to show that "all that may be either thought a priori in this concept, or presented in mathematical construction, or given as a determinate object of experience" must be brought under the categories (MAN, 4:474–75). Kant makes the following remark about this:

[5] The phrase "ontological commitments" and this general characterization are drawn from Detlefsen (1986, 2–3), in his description of Hilbert's finitist methods.

> "But in order to make possible the application of mathematics to the doctrine of body, which only through this can become natural science, principles for the *construction* of the concepts that belong to the possibility of matter in general must be introduced first. Therefore, a complete analysis of the concept of matter in general will have to be taken as the basis, and this is a task for pure philosophy – which, for this purpose, makes use of no particular experiences, but only that which it finds in the isolated (although intrinsically empirical) concept itself, in relation to the pure intuitions in space and time, and in accordance with laws that already essentially attach to the concept of nature in general, and is therefore a genuine *metaphysics of corporeal nature*." (MAN, 4:472).

Kant refers to this shortly thereafter (MAN, 4:478) as "detaching" the "metaphysical foundations of the doctrine of body" from the "general system of metaphysics," as well as from mathematical physics.

For any science to be complete requires, first, a critique of (pure) reason (Lu-Adler 2018, 134 and 179–80). Kant's notion of 'completeness' involves, not just the idea that a presentation is exhaustive, but the claim that the system in question is ordered by a principle or principles (MAN, Preface). That ordering allows for a decision on whether the system provides an exhaustive account of the concepts in use in the system, which then allows for an a priori account of how those concepts function in the system. In the case of MAN, the parts of the book lay out the specifications of the concept of matter.[6]

For Kant, conceptual exposition grounds the process of showing how a concept makes a difference to systematic thinking in some domain.[7] Concepts must first be 'analyzed,' that is, a complete list of their characteristic marks must be made and presented in an 'exposition,' before they can be employed systematically. But that exposition does not exhaust the possible a priori knowledge about that concept for

[6] I am grateful to a reviewer for raising this point.

[7] Here, I am following the persuasive account of Messina (2015) regarding the concept of "exposition", and I am using the term in a substantive sense here, as "a metaphysical exposition, for Kant, requires the analysis of a 'given concept', an analysis that justifies propositions describing the marks of the 'given concept' being analyzed"; and moreover, on Messina's novel account, "at least some of the marks uncovered in the analysis of a given concept correspond to essential features of the objects (or object) in the extension of the concept" (Messina 2015, 418). For Kant's account along these lines, Messina cites KrV (B37ff.) and Log (9:143), among other texts.

thinking within a given system. In particular, Kant argues that "principles for the *construction* of the concepts that belong to the possibility of matter in general" must be provided if natural science is to be possible. These principles involve the mathematical and dynamical properties of matter that can be derived from a theory of matter, which involves, as a priori principles, space, time, and the categories.[8]

In the MAN, Kant analyzes the concept of 'matter', and provides an exposition of the concept via four of its characteristic marks:

Phoronomy. "Matter is the movable in space." (MAN, 4:480)

Dynamics. "Matter is the movable, insofar as it fills a space. To fill a space means to resist any movable, which attempts to penetrate a certain space through its movement. A space that is not filled is an empty space." (MAN, 4:496, emphasis added)

Mechanics. "Matter is the movable, insofar as it has motive force in itself." (MAN, 4:536)

Phenomenology. "Matter is the movable, insofar as it as such can be an object of experience." (MAN, 4:554)

Listing the characteristic marks of central concepts is the first step to showing how those concepts function in one account of how we obtain knowledge a priori: by means of demonstrations, using those concepts. The second idea of 'completeness' here is that, via the Methodenlehre, every judgment can be referred back to a concept that has been characterized, in its essential features, in the Elementenlehre. Hence, 'completeness' is not restricted to the idea that we have exhausted the essential features of concepts in the Elementenlehre. It is defined in terms of the claim that the nexus of knowledge gained via those concepts can all be traced back to its sources or grounds, in a priori principles of construction.[9]

In the texts for which Kant distinguishes between an Elementenlehre and a Methodenlehre, it is crucial to distinguish between *metaphysical expositions of concepts* and *classification of elements as they work within a system*. Kant's four propositions that make up the parts of the *Metaphysical Foundations*

[8] Messina (2015) and Stang (2016) emphasize the *modal* reasoning that metaphysically substantive conceptual determinations of space and time can afford.

[9] For an explanation of how this works in the MAN, see Chapter 2 of Hyder (2009).

collectively provide an exhaustive list of the characteristic marks of the concepts of "matter" and "material body" (Patton 2017, 343). In the MAN, Kant explains how the concept of matter as object of experience can fit into a system complete in itself, without additional ontological commitments (e.g., to monads, God, or actual infinities).

The central problem of the MAN is to show that the concept of matter, with the four characteristics Kant ascribes to it, can be integrated into a system, based on the categories, which allows for judgments to be made about observable material bodies. But it turns out that for material bodies to be observable, for Kant, they must be ascribed certain causal powers. Then Kant must show, not only that material bodies can be observed in space and time, but that their interactions with other bodies are measurable using finite methods available to subjects of experience.

3. Matter as Phenomenal Substance

A central question of this paper is how Kant is able to argue that the a priori classification and elucidation of concepts such as "material body" can promote the completeness of the system of nature, including knowledge of the interaction between and motion of objects, which – as Kant argues himself – cannot be known a priori.[10] Instead, if we are to account for matter as a possible object of experience, we must ascribe certain properties to material bodies. These include causal powers that material bodies must have if they are to be experienced at all, and even if we are to experience temporal succession.

Kant's system of nature is constructed on the basis of his theory of matter as phenomenal substance. The laws he proposes are valid universally, but that 'universality' is founded on Kant's matter theory. For Kant, a theory of matter as *substantia phaenomenon* is necessary to solve fundamental problems in natural philosophy (Pollok 2002, 61–62). Such a theory requires determining what Warren (2001, 47–51) dubs the

[10] See the (in)famous footnote to B156, in which Kant argues that "Motion of an object does not belong in pure science and hence not in geometry, because it cannot be known a priori that something is moveable, but only in experience. But motion as the *describing* of a space is a pure Actus of the successive synthesis of the manifold in outer intuition as such through productive imagination and belongs not only to geometry, but also to transcendental philosophy." See Laywine (2020, 34n) and Friedman (2013, 85ff.) for recent discussion.

'comparatively inner' properties of matter. These are the properties elucidated by the relationships between the characteristics of material bodies considered independently of relation to other objects, with respect to how these features ground perceptible phenomena when material bodies *do* interact.

In the *Physical Monadology* of 1756, Kant had argued for an ontology of 'physical monads' with a sphere of activity (via forces of attraction and repulsion), but which were not observable. In his view developed after the MonPh*,* he argues that monads are not necessary to explaining the observed phenomena, and that material bodies can be known (only) through their causal interactions. However, Kant maintains the idea that the 'comparatively inner' properties of bodies are the basis for explaining the observable, measurable phenomena in which those bodies are involved, e.g., their interactions with each other.

In demonstrating how inner properties of matter can be made sensible and measurable, Kant now rejects the idea that monads are only intelligible and do not interact with other objects (Glezer 2018, 26–28; Pollok 2002, 75). However, as Warren notes, that does *not* mean that Kant abandons the idea that the measurable, sensible properties of matter are knowable, or that they cannot be traced back to the inner properties that ground them (Warren 2001; Pollok 2002, 64n7). For instance, a material body's taking up space is a result of its impenetrability (Warren 2001, Ch. 3). That is not just because we can determine the mechanical properties of the body quantitatively, but also because we can determine the dynamical properties with which bodies must be endowed, or else they would never become objects of sensible experience in the first place – for instance, a *force* of repulsion, which grounds impenetrability.[11]

It is correct to do as many commentators do, and to emphasize that Kant's path from the *Physical Monadology* was to develop a theory of matter that no longer depended on the idea of intelligible monads that do not interact with other substances. However, it is important to note that Kant does *not* reject the idea of giving a complete determination of a concept a priori by giving its characteristic marks. That is, in fact, his task in the *Metaphysical Foundations of Natural Science*: to provide an a priori exposition of the concept of matter (Patton 2017). Only if the concept of matter is given a complete exposition can we decide, for

[11] See Pollok (2002, 83); Warren (2001, 76–77); see McNulty (2019) for Kant's rejection of absolute impenetrability.

instance, whether a given judgment about an observable material body is analytic or synthetic: e.g., whether the predicate of the judgment is contained within the subject, or not (KrV, A6–7/B11).[12]

In the case of matter, the complete determination of what Warren (2001) calls the "inner relations" of a material body provides a ground for judgments about the *possible* relations of material bodies to perceiving subjects. These relations depend on the a priori features of space and time, as well as on the categories (Friedman 2013, 44).

It is well known that Kant argues that material bodies must be impenetrable if they are to be observable (Warren 2001). In addition, Kant argues that there are forces we must assume to exist if we are *not* to endow material substances with what Warren (2001) calls 'absolutely inner' properties: that is, if we are to consider matter as a phenomenon, not as a thing in itself.

The relationship between the properties of a concept (elucidated a priori) and the possible relations and interactions of observables that can be synthesized using that concept is:

(A) **Synthetic** (Warren 2001; Friedman 2013, 125–26);

(B) An argument for the **observability** and **reality** of matter based on its **causal powers** (Warren 2001, 77 and *passim*).

(A) The Principle of Succession as a Synthetic A Priori Principle

The relationship between the properties of a concept (elucidated a priori) and the possible relations and interactions of observables that can be synthesized using that concept is not analytic, but synthetic, because you cannot derive from the 'mere existence' or 'mere concept' of a thing that it will have *particular* relations to other objects. For Kant, we cannot know whether matter fills space by virtue of its 'mere existence' (Warren 2001, 70). More generally, it is not possible to derive from a description of matter or of a material body, hypothetically and a priori, an account of its *actual* relations with other objects. And Kant is clear, even as early as the MonPh, that a body cannot be known completely in isolation from all other material

[12] The model for this is the classification of the concepts of space and time in the *Critique of Pure Reason* (Messina 2015, 418).

bodies. Even in the last proposition of the *Nova Dilucidatio*, Kant notes that "finite substances by their mere existence are unrelated" (PND, 1:412–13; cited Warren 2001, 70). However, Kant can allow a *theory* of how the phenomena that can be unified under a concept would interact with other things, *if* we are to have knowledge of those interactions and of the properties that ground them.[13]

Kant's account of the possible interactions of material bodies is given as part of his clarification of the a priori foundations of Newtonian natural science, from his very earliest writings. Kant makes a number of such arguments during the pre-Critical period. In the *Metaphysical Foundations*, Kant will use Newtonian laws as the basis of his reasoning. As Schönfeld (2000) and Laywine (1993) remark, Kant's method in the *Metaphysical Foundations* is foreshadowed by another of Kant's early works: his doctoral dissertation, the *New Elucidation of the First Principles of Metaphysical Cognition* (1755), sometimes called the *Nova Dilucidatio*. Newton's laws in the *Principia* are:

> "1. Every body perseveres in its state of being at rest or of moving uniformly straight forward, except insofar as it is compelled to change its state by forces impressed. [law of inertia]
> 2. A change in motion is proportional to the motive force impressed and takes place along the straight line in which that force is impressed. [law of acceleration]
> 3. To any action there is always an opposite and equal reaction; in other words, the actions of two bodies upon each other are always equal and always opposite in direction. [law of interaction]" Newton (1999, 416–17)[14]

In the *Nova Dilucidatio*, Kant proposes as an axiom the "principle of succession":

> "No change can happen to substances except in so far as they are connected with other substances; their reciprocal dependency on each other determines their reciprocal changes of state." (PND, 1:410)

[13] As Pollok (2002) describes, beginning with the *PM* and continuing to the *MFNS*, Kant develops "an original theory of matter" (62). Such a theory is necessary to solve problems in "geometry and metaphysics", like whether space is divisible to infinity or not (*ibid.*). Pollok calls Kant's progress between 1756 and 1786 the "phenomenalization of nature."

[14] Discussion in Schönfeld (2000, 149).

There can be no change of state in a substance if it is not connected to some other substance. As we saw above, this claim is central to Kant's move away from his more Leibnizian position in the *Physical Monadology*. Along similar lines, Laywine (1993, 35–36) observes that the "principle of succession" in Kant seems to "stand in a peculiar relation" to Newton's laws of motion, because it seems to contain version of all three laws within itself, which Schönfeld summarizes as:

> "(1) no substance has the power to affect change in itself;
>
> (2) all change in a substance must be the effect of a connection with, or the action of, some other substance;
>
> (3) change of state in substances is mutual; that is, equal and opposite." (2000, 150)[15]

In the *Nova Dilucidatio*, Kant proposes the principles of succession and coexistence as axioms. As Laywine (1993) notes, Kant's arguments for the principle of succession appear weak *prima facie*: at best "contrived," at worst "question-begging" (33). As Laywine summarizes one argument:

> "If we deny real interaction among substances, we must conclude that every substance has within itself the sufficient reason of every change it will ever undergo. Kant's point is that these changes will unfold instantaneously unless there is some sufficient reason to delay them. The sufficient reason of this delay has to be outside of the substance. For so long as the substance has within itself the sufficient reason of all its future changes, it will not be reluctant – as it were – to bring these about. But if the substance presents all its future states all at once, it would not really undergo any change. So Kant concludes that something must act on the substance from without, otherwise no real change will take place in it." (Laywine 1993, 32)[16]

Kant seems to argue from whether change is *conceivable* in an isolated substance to whether change is *actually possible*, which appears to beg the question: *why* can't we conceive of change in such a substance?

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[15] Stan (2013) argues for Kant's continuing allegiance to Leibnizian mechanics, examining Kant's Principle of Action and Reaction as a foundation for Leibnizian mechanics, not a version of Newton's Third Law. I do not see my account here as in conflict with Stan's, since Stan argues – and I agree – that Kant's move away from Leibniz and toward Newton is found in the dynamics, not the mechanics.

[16] See PND (1:411).

If the ground of conceivability is intelligible and not physical, then it seems that Kant is missing an argument that physical change in an isolated substance must rest on the internal, intelligible principles of that substance.[17]

Laywine argues, however, that Kant's arguments for the principle of succession are stronger if they are understood to center on a more general question: "the possibility of any kind of temporal order in the world" (1993, 33). If changes in a substance take place instantaneously and result only from the internal powers of that substance rather than from real interaction, then no temporal order would result from the observable "order of succession" of changes in nature. For the changes will all take place instantaneously, and in accordance with the (possibly unobservable) internal principles of substances. But Kant argues, as Laywine points out, that time *is* that order of succession. If this is right, then, as early as the *Nova Dilucidatio*, we find Kant arguing that the principles or laws of nature are bound up with the status of space and time as principles of order (though not necessarily, yet, as a priori principles).[18]

One might extend this argument, in the MAN, to Kant's analysis of continuity and change. McNulty (2019) analyzes Kant's commitment to a dynamical theory of matter as resting on his "endorsement of Leibniz's law of continuity" (1597). McNulty argues that this endorsement is on metaphysical, not just mathematical grounds, and that it is fundamental to a number of Kantian texts (pp. 1599–1603). For instance, "In the General Remark to the Mechanics, Kant endorses a particular instantiation of the law of continuity, according to which mechanical communication of motion occurs bit-by-bit through an extended duration and not at an instant ([MAN,] 4:552f.)" (1603).

Kant's insistence that change, causality, and interaction be represented as taking place continuously over time is, of course, fundamental to his analysis of causality (Watkins 2005). It is also linked to his overall method in the MAN. In the Preface, Kant makes an explicit distinction between the a priori

[17] If we understand Kant to be working in a more Leibnizian framework in the *Nova Dilucidatio* than is sometimes assumed, this difficulty may be resolved to a degree (only to introduce difficulties associated with that framework, of course).

[18] For a substantial account of how time, especially, is involved in the argument and structure of the MAN, see Hyder (2009).

foundations of natural science, and the 'transcendental underpinning' found in Newtonian physics and related systems of natural philosophy (MAN, 4:472). The "natural philosophers" assume, according to Kant, that metaphysics could consist only in concepts and principles that are employed speculatively or inventively and argue that the better method of natural philosophy is to employ empirical principles that are "borrowed from experience." Kant argues that this is a false dichotomy, and that a third route is available:

> "All true metaphysics is drawn from the essence of the faculty of thinking itself… it contains the pure actions of thought, and thus a priori concepts and principles, which first bring the manifold of *empirical representations* into the law-governed connection through which it can become *empirical* **knowledge** [*Erkenntnis*], that is, experience." (MAN, 4:472; translation emended)

Kantian Critical metaphysics involves making explicit the principles originating in a priori thinking that first makes experience itself possible, and, through it, empirical knowledge of objects and phenomena. Kant emphasizes the need to investigate the *a priori sources* of the metaphysical principles bound up with mathematical physics, which "make the concept of their proper object, namely, matter, a priori suitable for application to outer experience, such as the concept of motion, the filling of space, inertia, and so on" (MAN, 4:472). These principles cannot be postulated: we cannot assume that matter is the movable in space, nor can we state that if matter is given then it follows without any argument that it is movable, fills space, has an inertial force, and so on. Instead, we must *demonstrate* that the concept of matter has these features.

That is the purpose of the *Metaphysical Foundations of Natural Science*: to demonstrate the *completeness* of the "metaphysics of corporeal nature" (MAN, 4:473) by showing that "All determinations of the general concept of a matter in general must be able to be brought under the four classes of [pure concepts of the understanding], those of *quantity*, of *quality*, of *relation*, and finally of *modality* – and so, too, must all that may be either thought a priori in this concept, or presented in mathematical construction, or given as a determinate object of experience" (MAN, 4: 474–75). Doing this requires, not only listing the

properties of matter, but also specifying how those features fit in an exposition of matter as a possible object of experience.

Showing how matter can be a possible object of experience requires demonstrating that material bodies can be observed in space and time. Fitting a theory of the interactions of material bodies into a system of nature requires ascribing continuous forces to those bodies, which requires, for instance, our ability to apply infinite division to bodies and their motions.[19] Those 'requirements' may not be logically necessary, but they can be physically necessary, if we are to show how matter can fit into a causal, temporal nexus.[20] Thus, while Kant argues that "true metaphysics" must be drawn from "pure actions of thought," he also argues that among those pure actions are proofs concerning how matter, its motion, and the actions of material bodies can be observable and measurable.

(B) Motion, Reality, and Causal Powers

In Kant's mature theory of matter, found in the MAN, we must ascribe causal efficacy to material bodies in order to explain, given the a priori exposition of the concept of 'material body,' how we can come to have sensible experience of phenomena unified by that concept. As Warren, Glezer, and Friedman analyze this, in order to be subsumed under the category of *reality*, matter must be understood as possessing causal *powers*.[21]

The *Metaphysical Foundations* begins with the proposition that "Matter is the movable in space." Each of the chapters adds a determination to that proposition.[22] Given that matter is *the movable* (in space), it is not possible to determine a priori that a particular material body has actually moved, according to the following reasoning, which is my own synthesis and reconstruction of recent work on this subject.[23]

[19] This may seem to cut against a finitist reading of Kant – but see section 4 below.

[20] See Massimi (2017a) for the idea of a causal nexus in Kant.

[21] A main thesis of Warren (2001) and Glezer (2018).

[22] See Patton (2017), including the references there.

[23] McLear (2018) provides a relevant analysis of motion as the fundamental determination of matter.

(A) According to Kant's principle of relativity, it is one and the same a priori whether an object is seen as taking a particular path with respect to the subject, or taking another, opposite path with respect to another frame of reference.[24]

(B) An object cannot be determined to move in isolation from all other objects (the principle of succession). In particular, if we cannot show that an object has made a measurable difference to the motion of another object, then there is no *real* phenomenon of motion to be observed, and there is no determinably real alteration to the state of any object.[25] One reason for that is because the possible motions the object could take with respect to other objects, including the observing subject, will sum to zero.[26]

(C) Thus, to observe or to know an object's real motion requires being able to determine an object's causal interactions with other objects.

(D) Finally, therefore, material objects must be considered to be endowed with causal powers if their motion is to be measurable or quantifiable, and if they are to fall under the category of reality.[27]

It is entirely possible that bodies may have properties, including causal properties, that are "absolutely inner" in Warren's terms: that is, the properties are determinable in isolation from any possible relation to another object. For Kant, we cannot know those properties, for these would be properties of things in themselves (Warren 2001, Ch. 2 §3). We can, however, know bodies' "comparatively inner" determinations: specifications that are grounded in perceptible internal relations of the body, which describe possible relations with other objects, including causal powers to affect them (Warren 2001, 43).

Analysis of comparatively inner properties a priori yields only potential effects, including potential alterations to a body's state of motion. However, if something is a material body, we know a priori that it

[24] Friedman (2013).
[25] Friedman (2013, 291); Warren (2001, 50); Glezer (2018, 67).
[26] Patton (2011).
[27] Warren (2001, Ch. 3 §5 and *passim*); Glezer (2018, Chs. 4 and 5).

is *movable* and endowed with its own comparatively inner properties, which ground the *possible* interactions it may have with the original object in question.[28]

With Glezer, Warren, and Friedman, we can conclude that, in the MAN, matter is real to us insofar as we can measure its "force or power" to alter the motion or state of other objects. In Leibniz, substantial forms are *intelligible*.[29] They ground, in turn, the intelligibility of our ascription of properties to objects. In moving away from the *Physical Monadology* and toward the *Metaphysical Foundations of Natural Science*, Kant's challenge is to show that "substantial form," i.e., "the grounding of properties in the individual essences of substance," can be shown to function in a framework in which *all* of the properties of those substances are *phenomenal*. And he needs to do this instead of showing that observable properties are grounded in purely intelligible essences.

Kant provides an account of how properties are grounded in the 'essences' of substances, but where that essence is defined entirely in terms of phenomenal properties. This is done by showing that a physically complete system of forces in nature is grounded in an account of the essence of matter as *substantia phaenomenon*. That account of the essence or nature of matter does put conditions on the elaboration of a system of nature, consistent with the Necessitation Account. But, in turn, the requirements for enumerating a system of nature, in terms of a nexus of finite, observable substances and their interactions, set conditions for the exposition of the concept of matter.

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[28] One might object to my reading (here and in Patton 2017) that it seems to ascribe a version of the old substance-accident metaphysics to Kant. Pollok (2002, 85n69) has raised a similar objection to this kind of reading. Without giving a full response, it is worth noting that Glezer (2018) defends a cogent picture where Kant's category of reality "descends from Early Modern – especially, Leibnizian – versions of the Scholastic concept of *realitas*, often identified with that of *substantial form*… reality's central role in Kant's thought is analogous to the central role of substantial forms in seventeenth-century debates over the nature of physical bodies and physical explanation" (3). For instance, in Leibniz's letter to de Beauval, we find the claim that what is real in motion "is *force* or power" (G IV, 523; L 496; cited in Glezer 2018, Ch. 2). The question of Leibniz's – as opposed to Wolff's – influence on Kant is complex. For skepticism about how much Leibniz Kant knew firsthand, see Garber (2008). For the view that Kant could have read much of Leibniz's works and correspondence, see Storrie (2015) and McNulty (2019).

[29] "Even if it is impossible fully to articulate the relation between the essences of substances and their phenomenal manifestation as quantifiable physical forces, Leibniz can justify their intelligibility to the extent that he can provide a metaphysical picture in which each substance is characterized by an individual essence that determines all its features, and so functions as the basis for the entire series of its phenomenal states. This idea of a thoroughly determined substance, represented by a complete concept, is the idea of the Leibnizian *monad*, the centerpiece of Leibniz's mature metaphysics" (Glezer 2018, 47).

4. Finitism and Kant's Matter Theory

It is odd that finitist readings of Kant have not had more purchase to date. It is well known by now, almost a philosophical cliché, that among Kant's motivations for the Critical turn was to rein in metaphysical speculation about God and the infinite by limiting knowledge claims to what can be proven of objects of a possible experience. And, later, David Hilbert and Paul Bernays "justify finitary knowledge in broadly Kantian terms (without however going so far as to provide a transcendental deduction), characterizing finitary reasoning as the kind of reasoning that underlies all mathematical, and indeed, scientific, thinking, and without which such thought would be impossible" (Zach 2019, §2.1).

Tait (2016) has argued recently that Kant's theory of arithmetic is "finitist" in Tait's own sense, that it "refers to the mathematics that is capable of proving general propositions about the natural numbers without presupposing any infinite objects (actual infinities)—such as the totality of natural numbers" (261). Clearly, in proposing a Finitist Account of Kant on the laws of nature, I am not arguing that Kant's matter theory is finitist in this exact sense. But I do want to argue that it is finitist in a broader sense.[30] The key characteristics of finitism for my purposes are:

(1) Finitism does not appeal to actually infinite objects or magnitudes (an infinite universe, an infinity of monads, the infinite sensorium of God, the totality of the natural numbers, and the like),

(2) Finitism appeals to finite, concrete, usually intuitive construction procedures in generating a domain, and

(3) Finitism appeals to explanations using systems of axioms or principles to demonstrate that the construction procedures in (2) are finite (and will not need to be extended to the infinite) in the domain of interest.

[30] One might object, on grounds of anachronism, that one should not apply this term to Kant. I might agree, and then note that, on the same grounds, one shouldn't say Kant has a Best System Interpretation. Insofar as both are being used as evaluative, rather than straightforwardly descriptive, categories, some leeway can perhaps be given. Moreover, there is an argument – of course, not given in this paper – that Hilbert's finitism is derived partly from Kant's, and thus even the historical category may be appropriate.

In these three ways, Kant uses finitist methods in the MAN.

Kant needs a theory of matter as phenomenal substance. This theory must demonstrate how law-governed observable interactions are grounded in the comparatively inner properties of material bodies. The physical system of nature that Kant constructs cannot be metaphysically complete in the sense that Leibniz's system is, because Kant rules out the appeal to absolutely inner properties of simple substances. According to his own principles, Kant cannot argue, for instance, that the apparent infinite divisibility of substances is resolved by arguing that substances are composed of metaphysically simple monads.[31] Nor can Kant's system be given the "final vehicles" (e.g., God) with which Newton endows his natural philosophy. Instead, the exposition of the concept of matter engages with the theory of matter as observable substantial phenomenon in the MAN.

In *The Philosophy of the Young Kant*, Martin Schönfeld charts the wandering path of the young Kant between the metaphysics of the Leibniz-Wolff school and the Newtonian method of mathematical natural science (Schönfeld 2000). In *Universal Natural History and Theory of the Heavens* (1755), Kant conceives of a teleology that rests on the Newtonian forces of attraction and repulsion.[32] Kant's use of immanent forces to explain what Newton (supposedly) had explained using extrinsic agency means that Kant already is trying to show that the dynamical framework of nature is a self-sufficient system. Kant uses the Newtonian laws to explain how nature could sustain itself without the teleological background and could consist of a system of interacting forces that contribute to the continuation of that system.

Kant's arguments are motivated by the desire to avoid an appeal to actual infinity – Leibniz's infinity of monads, for instance – and to avoid Newton's and Descartes's accounts of God as law-giver, which provide an extrinsically grounded, rather than an immanent, law-governed framework to nature. Both of these desires are deeply finitist in nature and exemplify characteristic (1) above.

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[31] On Leibniz's changing views on the "substantial bond" theory, see Garber (2008, 75–77), *passim*; Storrie (2015, §1).

[32] Schönfeld identifies Kant's selection of "the Newtonian forces of attraction and repulsion as the vehicles for nature's unfolding toward perfection" as, "paradoxically, his point of departure from Newton" (Schönfeld 2000, §5.3).

The second characteristic of finitism above is: "Finitism appeals to finite, concrete, usually intuitive construction procedures in generating a domain." Here, there may seem to be a snag for interpreting Kant as a finitist. Kant endorsed Leibniz's law of continuity throughout his career (McNulty 2019), and, arguably, this law requires being able to divide matter to infinity.

But, in fact, Kant makes characteristically finitist arguments in laying out his dynamical theory of matter. He argues that we must show that the principles of mathematical construction apply to material bodies and their motions. Those principles may themselves appeal to infinite processes (division to infinity, for instance). But these regulative, mathematical rules do not require that we engage in constitutive physical reasoning using actual infinities. Kant is definite in not ascribing actual infinite extension to the universe, or actual infinite divisibility to any substance.

As McRobert (1995) analyzes the role of mathematical construction in the MAN, "Kant's argument in the Dynamics makes clear that construction is a procedure which is necessary to exhibit the mathematical part of a concept. The problem, as Kant sees it, is neither mathematicians nor metaphysicians had shown why mathematics applies to matter" (98). As McRobert cites Kant in the Dynamics section,

> "For it does not necessarily follow that matter is physically divisible to infinity, even if it is so from a mathematical point of view, even if every part of space is a space in turn, and thus always contains [more] parts external to one another. For so far it cannot be proved that in each of the possible parts of this *filled* space there is also *substance*, which therefore also exists in separation from all else as movable in itself."(MAN, 4:505–6)[33]

McRobert continues:

> "This 'something', Kant maintains, is a constructive procedure which can be infinitely continued, and in terms of which matter can be represented as infinitely divisible. In the Dynamics, Kant's preference for a dynamical concept of matter is explained in light of the constructive procedure

[33] The passage quoted from Kant picks up on many of the preoccupations of Émilie du Châtelet in her *Institutions de Physique* (*Foundations of Physics*), an important source of context for Kant's arguments in this regard (see du Châtelet 1750/2014). Holden (2004) does not discuss du Châtelet, but investigates the debates over the metaphysical, geometrical, and mathematical concepts of matter.

[533-534], which requires that the iteration of an operation be possible indefinitely." (McRobert 1995, 99)

Reason demands the infinite divisibility of matter as a regulative principle. This demand does *not* promote the completeness of the system of nature, if we consider that system to consist of observable phenomena. In fact, it detracts from it, by showing that any actual, observable division of matter is incomplete and can be taken further. But if we can show that no physical division is a division into real parts, because geometrical divisions applied to physical bodies are divisions in thought but not in actuality, then we can ground the (geometrical) division of matter to infinity without requiring that matter be an aggregate of an infinite number of (real, physical) parts.

And that is exactly what Kant goes on to say (MAN, 4:506–7). *Reason* can make a demand for infinite division. The *understanding* can show that no infinite aggregate of parts can be brought under the conditions of the possibility of actual experience. No rule for the connection of representations can be given such that an infinite aggregate can be constructed. And this fact, that no rule can be given, can be demonstrated a priori, despite its involvement of an empirical concept (matter or material body). Geometrical division is not real division.[34] Kant can demonstrate this, because he can show that, despite reason's demand for infinite division, we cannot have *experience* of a material body with infinite parts. We cannot provide any principle for the law-governed connection of representations that would be the basis of such an experience.

Kant's account of mathematical construction and its application to the concept of matter in the Dynamics thus exhibits the crucial characteristics of finitist theories. First, it requires what's sometimes called the "surveyability" of objects in the domain of interest (Sieg 2016, 278). Second, it relies on the conditions for producing demonstrations via finite construction and derivation procedures. Of course, in the Antinomies, Kant argues that one *could* build a system using actual infinities, if one chooses. However,

[34] See Holden (2004) for detailed discussion.

a key task of the MAN is to show that one can also build a complete system of nature without appeal to actual infinities.

A final objection may occur to insightful readers. After all, Kant *does* appeal to two infinite given magnitudes in his proofs: space and time. And so one might object that Kant is not a finitist (noting that this objection would apply to Tait 2016 as well).

I cannot resolve this complex question here but will point toward an answer. It depends very much on what Kant means when he says that space and time are "infinite given magnitudes." On my own reading, the statement that space and time are infinite given magnitudes applies only to Kantian metaphysical space and time, as opposed to particular, constructed, empirical spaces and times.[35] Metaphysical space and time contain, not just the *actual* constructed measures of space and time, but any *possible* measures, and this is why Kant argues that the entire measure of metaphysical space and time is zero (Patton 2011, 184). The set of all such measures contains all the possible magnitudes that could be generated from a subject's position. That set is 'infinite' in Galileo's sense, but is not an 'actual infinity' in any sense that conflicts with a finitist reading of Kant.[36]

5. Conclusion

The reconstruction above focuses on several interlocking features of Kant's view:

- Kant appeals to the 'real essences' or natures of material bodies (attainable by a priori exposition) in proofs, following a "mathematical method," of how material bodies and their motions and interactions can be
    - Observable, and
    - Part of a complete system of nature.

[35] For a proposed distinction between "original," "geometrical," and "metaphysical" space in Kant, and for a somewhat different reading of Kant on space and time, see Tolley (2016). For the purposes of evaluating Kant's finitism, nothing hangs on whether we call the a priori space and time I'm discussing in what follows "original" or "metaphysical."

[36] See Patton (2011, 282ff.). Kant argues that any actual measure of geometrical magnitudes must take place in time, an argument that dovetails well with the arguments above from Laywine (1993) on the principle of succession and McNulty (2019) on the law of continuity.

- Kant's "completeness" in the MAN has two key elements:
    - It is derivable from the natures of material bodies, working with the a priori principles of space, time, and the categories, along with certain methodological principles. These include that bodies must be objects of a possible experience to form part of a system of knowledge.
    - It is "complete" in the sense that any possible experience of an epistemic subject must be classifiable as part of the nexus of relations it specifies.

Kant's comprehensive specification of the features ("real essences") of material bodies is the basis of his argument that we can construct a complete system of nature without appeal to actual infinities. Kant's finitism works hand in hand with his necessitarianism, and each puts limits on the other. For Kant, necessitarianism may not extend to positing a monadology when specifying the natures of objects: those natures may not include positing actual infinities or purely intelligible, unobservable substances. So Kant's finitism puts limits on any Necessitarian reading of Kant. On the other hand, Kant's finitist proofs are limited to those that can be elaborated in terms of observable material bodies and their phenomenal interactions.

In general, I do not think one needs to choose only one of Kreines' readings of Kant on the laws of nature. Kant's system, in my view, is a blend of Necessitarianism and Finitism. The modal judgments that constitute the 'edges' of the system of corporeal nature in the *Metaphysical Foundations of Natural Science* do not ground limits in principle, or absolute limits. They are determined by the limits of the constructibility of proofs on the basis of the empirical concept of observable material body. They are explanations and descriptions of what it would mean for a system of nature to be constituted without outside intervention and without the need to make metaphysical postulates of God, Freedom, or Infinity: of what a science of nature that is complete in itself would be.[37]

[37] Michael Bennett McNulty extended a gracious invitation to contribute to this volume and has provided substantial comments on drafts of the paper. I presented an early version of this paper remotely at a workshop hosted by McNulty and by Katherine Dunlop, at which I received insightful suggestions and remarks from Dunlop, McNulty, Daniel Warren, Silvia di Bianchi, and James Messina.