

MAGNITUDE, MATTER, AND KANT'S PRINCIPLE OF MECHANISM

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ABSTRACT

For Kant, inquiry into nature properly requires seeking to explain all material wholes merely mechanically, in terms of their parts. There is no consensus on how he justifies this Principle of Mechanism. I argue that Kant seeks to derive this claim about part and wholes neither from his laws or mechanics, nor from the mere discursivity of our understanding (two standard options in the literature), but instead from a priori principles laid out in the first *Critique*, which govern parts, wholes, and magnitudes. These principles are also fundamental to Kant's account of mathematics. Therefore, Kant's Principle of Mechanism and his philosophy of mathematics have common foundations.

We must strive as much as we can, Kant holds, to explain nature in merely mechanical terms. He considers this an indispensable guideline for scientific inquiry, for example in the discovery of empirical laws. It complements the third *Critique*'s more famous claim that organisms must be studied in some special way that is not merely mechanical.

Several commentators have observed that parts and wholes figure in Kant's definition of mechanism, and therefore in fixing the meaning of this Principle of Mechanism. In mere mechanism, parts are prior to the whole, whereas in final-causal explanation the whole is prior to its parts.

What remains unclear is how he justifies building the priority of parts over wholes into his Principle of Mechanism. I offer a new account of how this works. In the first of three main sections, I lay out the part-whole content of the Principle of Mechanism, which consist in a norm of judging all material things as at least partly determined by smaller-scale material parts and their properties. The second section criticizes two rival accounts of how he justifies this principle. In the third section, I defend the paper's core exegetical thesis: the part-whole commitments of the Principle of Mechanism crucially depend on his foundations of magnitude as set out in the first *Critique*. Given transcendental idealism, the basic characteristics of magnitude determine some general metaphysical features of parts and wholes a priori. When combined with Kant's broader account of the norms of rational inquiry, his foundations of magnitude show why the Principle of Mechanism enjoins explaining material entities in terms of their parts.

My aims in this paper are modest. I focus on the Principle of Mechanism in the third *Critique*, and do not attempt a unified account of Kant's various uses of the term

‘mechanism.’¹ Nor do I seek to resolve philosophical difficulties in his foundational claims about magnitude. An upshot of my reading, however, is that these foundations of magnitude—and any problems that do arise for them—have consequences in an unexpected area, namely the third *Critique*’s account of mechanism.

1. KANT’S PRINCIPLE OF MECHANISM

Before analyzing the Principle of Mechanism itself, consider a few reasons why it is significant. First, the Principle is supposed to provide an indispensable “guideline” (*Leitfaden*) for science, helping us “spy out” natural laws (CPJ 5:386). Kant goes on to say that if it is not “made the basis for research then there can be no proper cognition of nature” (5:387). For an initial hint as to what he means by this, we can look to his well-known comparison between scientific approaches to a stone and an eye. Though he ultimately wants to stress the differences between the two cases, in *both* cases inquirers ought to start with a “merely” mechanical account of the object’s “outer and internal structure,” or the “character of all...[its] parts and their composition” (FI 20:240). An anatomist will then go further and propose functional explanations of—or final-causal laws for—the parts of the eye.² The character of a part must meet some requirements in order to fulfill a given function, so the mechanical account constrains what the possible function of each part could be. The anatomist’s choice of hypotheses would be arbitrary without reference to an initial investigation into the character and structure of parts.

Second, the Principle of Mechanism has a broad scope, and a kind of necessity. The Principle governs judgments about all material things whatsoever. In Kant’s terminology, in exercising reflective judgment we must make the merely subjectively valid assumption that empirical laws form a possible unified system. But to actually discover and unify empirical laws, we also need so-called *principles of reflection*, which may have an objective basis. An example is the Principle of Mechanism, which has its objective basis “provided...by the mere understanding a priori” (CPJ 5:386). The Principle is not contingent, like an empirical law, but “necessary” (5:385). The Principle can be violated, and states what “I should” do, so this

¹ For a summary, see Ginsborg (2015, 263–64). Especially important are (1) a narrow sense of ‘mechanism’ that refers to contact action of bodies on one another merely in virtue of their size and shape (4:530–33; 12:33); and (2) a broad sense, synonymous with natural determinism (Bxxvii; CPrR 5:6(n.); MFNS 4:458; L-Met 28:1066). Kant rejects (1) since he takes matter to have inherent forces of attraction and repulsion. We’ll also see that mere determinism (2) is not sufficient for mechanism as Kant understands it in the Principle of Mechanism.

² On final-causal empirical laws see FI 20:234; CPJ 5:360; 5:377; 5:382; 5:387; 5:415.

necessity is normative (5:387). To follow it is to carry out the “highest vocation” of theoretical reason, so it expresses a norm for theoretical inquiry rather than a moral obligation (5:410).

Third, the Principle complements Kant’s famous assessment of the explanatory status of organisms:

It is quite certain that we can never adequately come to know [*kennen lernen*] the organized beings and their internal possibility in accordance with merely mechanical principles of nature, let alone explain them (CPJ 5:400; cf. 5:387; 5:398).

This dictum makes essential, though negative, reference to merely mechanical principles. As such, fully understanding this claim about organized beings requires an adequate understanding of what Kant means by mere mechanism.

Kant states his principle of the mere mechanism of nature as follows:

(PM) “all generation of material things and their forms must be judged as possible in accordance with merely mechanical laws” (CPJ 5:387).

Material things consist of parts. So the generation of a material thing and its form involves, at least, the “separation and new composition” of some pre-existing matter or stuff, and Kant accordingly calls mechanism a “mode of composition.”³

Since generation is also a causal process, it’s worth clarifying how PM relates to Kant’s general causal principle from the first *Critique*, which enjoins that all changes have a temporally prior cause. Kant’s causal principle—which he calls the “Principle of Generation [*Erzeugung*]”—entails that all material generation is at least possibly subject to empirical causal laws (A189). Like most interpreters, I take this causal principle to be silent on whether material things must be judged in terms of merely mechanical laws, as PM dictates.⁴ Instead, the causal principle leaves two options for judging how this separation and combination of matter is possible. We can either judge that this separation and combination of matter requires distinctively final-causal laws (possibly in combination with mechanical laws) or else, in accordance with PM, judge that this process is possible through *merely* mechanical laws. In Kant’s view, there is no third option.

So an initial, negative gloss on merely mechanical laws is that they are *non-final-causal* laws. Final-causal explanation makes a distinctive assumption about composition,

³ CPJ 5:371; L-Met 29:935. This leaves room for composites that are not merely mechanical (compare Refl 17:293). Baumgarten by contrast assumed that mechanism and composition are coextensive (1763, §431; §433).

⁴ Thus PM is “the principle of the mechanical kind of generation,” rather than the principle of all generation (CPJ 5:429; the Cambridge translation incorrectly renders ‘*Erzeugungsart*’ as ‘explanation’). For consensus that PM is more specific than the causal principle, see Allison (2012, 202–3), Breitenbach (2006), Cohen (2004, 187), Huneman (2008, 493n57), McLaughlin (1990, 2014), and Zuckert (2007, 102).

namely that “the possibility of the parts (as concerns both their existence and their form) must depend on their relation to the whole” (CPJ 5:373). To make this clearer, consider Kant’s example of a tree’s growth, which he says must be understood completely differently from “any” merely mechanical “increase in size” (5:371). Although the tree must use external and pre-existing “essential components” (*Bestandteile*), such as nutrients, an explanation of the tree’s growth assumes the dependence of parts on the whole (5:371). A new part of a tree, such as a developing leaf, is final-causally explained by reference to a unified *idea* of the tree as a whole.⁵ This provides an end towards which the leaf’s composition is directed. By contrast,

it is entirely contrary to the nature of physical-mechanical causes that the whole should be the cause of the possibility of the causality of the parts, rather the latter must be given first in order for the possibility of a whole to be comprehended from it. (FI 20:236; also see 20:219)

So here is a negative characterization of explanation in accordance with merely mechanical laws: it is explanation where the possibility of the parts does *not* depend on a whole that somehow grounds these parts’ manner of unification.

This raises the question of what, positively, makes causation and its accompanying laws merely mechanical. Kant suggests that merely mechanical laws use parts and their properties to explain the wholes that these parts make up:

If we consider a material whole, as far as its form is concerned, as a product of the parts and of their forces and of their capacity to combine by themselves (including as parts other material that they add to themselves), then we represent a mechanical kind of generation. (CPJ 5:408)

He calls wholes that are explained merely mechanically *mere aggregates*:

We see soil, stones, minerals, etc., without any purposive form, as mere aggregates... With regard to its products as aggregates, nature proceeds mechanically. (FI 20:217)

His thought is that the mass and shape of a stone or lump of soil can be explained just in terms of its parts and their properties. The properties he mentions are size, shape, forces, and capacity to combine. This suggests that empirical laws are merely mechanical just in case they

⁵ In greater detail, organisms are here explained by taking their “possibility,” as material composites, to be “ground[ed]” in an “idea,” or a concept that has “absolute unity” prior to its representational components (CPJ 5:377). This unified representation is taken as grounding an organism’s “determinate unity of composition,” that is, how its parts are composed into a whole (5:377). While space does not permit detailed discussion of the ‘taking as’ invoked here, Kant allows that the relevant grounding relation might lie “only in the idea of the one who judges” (5:376).

explain wholes in terms of their individual parts and the properties of those parts—including size, shape, forces, and capacity to combine.

A merely mechanical account of bodies need not begin by inventorying the parts through observation and then deducing the properties of the body they compose. Instead, as in the examples of the stone and eye, features of the parts may be postulated to explain observed properties of bodies. For example, having stated that the attractive force exerted by a body depends on “the aggregate of matter in a given space,” Kant appeals to short-range attractive forces within bodies to explain their cohesion and elasticity.⁶ He does not purport to give a complete account of these properties. The short-range forces are not directly observed, and he brackets attractive forces that apply to bodies from outside. While his commitment to short-range forces of cohesion has a partly empirical basis—inductive evidence of universal attraction, and perhaps inference to the best explanation of macroscopic bodies—I don’t take this to be the full story. The assumption of cohesion forces conforms to Kant’s global constraints on acceptable explanations, including the Principle of Mechanism. This brings us back to the initial question of what justifies accepting the Principle of Mechanism itself.

Plugging Kant’s statements about mere mechanism into the Principle of Mechanism would yield something like

(PM*) All generation of material things and their forms must be judged as possible in accordance with laws whereby the form and possibility of a whole material thing is fully determined by its parts and their properties.

This formulation requires further qualification to be strictly accurate.⁷ But it narrows our focus in a helpful way, bringing to the fore what might be called *the part-whole content of the Principle of Mechanism*. Kant’s definition of mere mechanism, in other words, includes the priority of parts over the whole. What calls out for further explanation is not the definition itself, but rather why mere mechanism so defined figures in a general normative principle about the explanation of material things. Several interpreters have noticed this. Peter

⁶ MFNS 4:524; 4:526–30. More precisely, Kant seeks to explain the “attractive elasticity” of a body stretched in one direction, such as “an iron wire stretched by a hanging weight” (4:529). He does not mention a specific law. Up to a certain degree of stretch, the force needed to extend the wire can be approximated by Hooke’s law.

⁷ ‘Fully determined by its material parts’ would need amendment to allow causal interaction between disjoint material things, as well as non-empirical determination by categories and forms of intuition.

McLaughlin, for example, has asked for “a compelling argument immanent to Kant’s system” that could support PM*, though he doesn’t think such an argument can be found.⁸

To get a better sense of why the argument in question ought to have a systematic rather than merely empirical basis, consider two historically relevant objections to Kant’s principle of mechanism. First, Humeans could object that if anything leads us to favor the explanation of material wholes by their parts, it could only be custom or instinct, independent of reason or understanding (Hume 1975, 43). No universality or strong normativity could follow from that, Kant thinks. Second, pantheists, who think God or the cosmos literally determines its material parts, could object that our judgments about the material world need to reflect the priority of the whole.⁹ Mere inductive evidence could not conclusively refute a global metaphysical claim like pantheism.

Kant thinks the Principle can be defended against these objections, because in his view it is not justified on a merely empirical basis. Although it is a normative principle dictating how things ought to be judged, it has “logical objective necessity” (CPJ 5:182). Interpretations of Kantian mechanism should do justice to this ambition by showing where PM* is supposed to get its generality and normative force. Before turning to my own proposal, which appeals to Kant’s foundations of magnitude, in the next section I critically consider the two most promising candidates for the sort of immanent argument that McLaughlin calls for.

2. PARTS, WHOLES, AND MECHANISM: TWO INTERPRETATIONS

One interpretive strategy is suggested by the fact that the principle of mechanism ranges over material things. The justification of the principle might be based in Kant’s account of matter, and specifically the account given in the *Metaphysical Foundations*. Thus Angela Breitenbach (2006), among others, has connected mechanism to Kant’s version of the law of inertia.¹⁰ This law, which Kant presents as applying his general principle of causality to matter, states that “every change in matter has an external cause” (MFNS 4:544). Kant concludes that matter is “lifeless,” in that it lacks an internal principle of motion (4:544).

⁸ McLaughlin (2014, 155; 161); also see Breitenbach (2006), Zuckert (2007, 102), Huneman (2008, 286–302), Allison (2012, 202–3), and Watkins (2019, 173).

⁹ “Pantheism...takes the totality of things to be God, as *partes constituae* in space, wherein things would be modified...as bodies”: everything is a part of God and also asymmetrically depends on God (27:719; cf. 5:439–40).

¹⁰ The others include Friedman (2006, 56), Zuckert (2007, 106), Teufel (2011, 254), and Guyer (2021, 248). For criticism, see Allison (2012, 202–3) and Watkins (2019, 156–57).

A problem with this interpretation is that in the third *Critique*, Kant does not use lifelessness to characterize mechanism. He defines life as a capacity for certain representational states, such as desire or sensory representation, but does not define organisms as living things.¹¹ Kant’s assertion of the mechanical inexplicability of organisms makes no commitment to their having any representational faculty that would act, for example, according to desires or intentions (CPJ 5:392). Therefore the absence of life, understood as a representational capacity, cannot suffice to characterize Kantian mechanism.

Another difficulty for this reading is that PM is supposed to be provided a priori by our understanding: it follows from the “constitution” or “kind and limitation” of this faculty.¹² But the propositions in the *Metaphysical Foundations* cannot be provided merely by the properties of the understanding, or even by the intrinsic properties of the understanding plus the transcendental schemata. Instead, the *Foundations* begins with a concept of matter in motion that is “intrinsically empirical” and so “must be given empirically.”¹³ The concept rests on the contingent, empirical fact that our outer senses can “only” be “affected” by motion (MFNS 4:476–77).¹⁴ This does not follow from the constitution of our understanding. We could conceivably have the same kind of understanding, but somehow be able to sense forces from a distance, or to “intuit the future” (A223/B270).

To be sure, PM mentions material entities. But I take Kant to be invoking a transcendental concept of matter that is broader than the one employed in the *Foundations*. In this transcendental sense, material objects are whatever can be given to the outer or spatial senses of a finite being, leaving aside how that being is sensibly affected.¹⁵ Matter in this transcendental sense is extended and divisible:

Material is that which is or can be a constituent part of some matter, and matter is the extended thing that consists of such parts. (L-Met 29:929)

¹¹ See CPrR 5:9; CPJ 5:464n.; ID 2:330; Huneman (2008, 216–46); Nunez (2021). At the time, it was common to distinguish organization and life. After defining life as a capacity for certain representational states, for example, Eberhard and Reimarus conclude that plants are organized but lifeless. Conversely, Maupertuis (1756)—a work Kant owned in German translation and likely one of his targets—posits material elements that perceive and move themselves, but are not organized out of parts.

¹² See CPJ 5:386; also see 5:370; 5:417; 5:427; ID 2:405.

¹³ See A41/B58; A398; MFNS 4:470; 4:472; CPJ 5:181; L-Met 29:931; 29:946.

¹⁴ See further Pollok (2001, 149–65) and Watkins (2019, 78–81). For Plaass (1965, §4.1; §5.3), Kant derives this concept of motion a priori from pure space and time. Plaass, however, elides Kant’s distinction between motion as a subjective a priori “synthesis of the manifold in space,” and as an objective a posteriori determination of a *thing* as “something movable” (B155; A41/B58).

¹⁵ See A358; A469/B497; L-Log 24:816.

That a body is composite, I cannot know from experience: I cannot see the composition. Here there is a mere act of thinking, although at first sight the concept of composition seems to be made *a posteriori*. (29:978)

Kant concludes that it is a logical contradiction to predicate non-extension or indivisibility of matter (29:812).¹⁶ However, these properties do not entail that matter is movable. Instead, the actual existence of “the movable” is “an empirical datum” rooted in the character of our sense organs (A41/B58). So these general properties do not entail a law of inertia. They also do not entail that matter has mass or weight, as these predicates are not included in the general concept of a body (A8/B12). Finally, this general concept does not settle how division into parts takes place or whether matter is physically (rather than just metaphysically) divisible.¹⁷ Consequently, the reference to ‘material things’ in the Principle of Mechanism need not be construed in terms of the more specific account of matter in the *Foundations*.

On a more conciliatory note: Breitenbach’s reading might be seen as *complemented* by my own proposal, given that I focus specifically on the part–whole content of the Principle of Mechanism. For Kant reportedly suggests that mechanism has both formal and material aspects:

Mechanism is the mode of composition of a machine. It is the formal aspect, just as the motive power is the material law in nature. (L-Met 29:935)

Here an account of the motive power of bodies—which may invoke the law of inertia—does figure in Kant’s account of mechanism, as its material aspect or law. But Kant also invokes a formal aspect, namely a certain mode of composition. The formal aspect corresponds to what I’ve called PM*, or the specifically part–whole content of the principle of mechanism. On the plausible assumption that these formal and material aspects of mechanism are irreducible to one another, Breitenbach’s reading will only provide a basis for its material aspect. There is still a need to understand the formal aspect.¹⁸

¹⁶ Though I cannot go into the details here, this concept of matter also includes reality and/or substantiality, unlike pure mathematical concepts (A7/B11; A441/B469; A526/B554).

¹⁷ See MFNS 4:505; L-Met 28:568; 29:931.

¹⁸ The same goes for Ginsborg’s (2015, 289) proposal that a necessary condition for merely mechanical explanation is that it only invoke attractive and repulsive forces. For Kant, <form> and <matter> are not concepts of objects but higher-order concepts, namely concepts of a “relation” between first-order concepts (A261/B317; Longuenesse 1998, 124). So the form–matter distinction is relative to the concepts it relates: something can be form in one respect and matter in another (Sutherland 2022, 42–43).

A second interpretive approach seeks to base the principle of mechanism on the generality of our concepts and thoughts, or what Kant calls their discursivity.¹⁹ The only kinds of concepts and thoughts we can have are discursive, and this distinguishes them from intuitions, even though there might be thinkers for whom this is not true.

Since discursivity is supposed to be a constitutive feature of our understanding, this proposal does justice to PM's connection to our particular kind of understanding, as well as to its generality and normativity. The proposal can also handle Kant's view that if a being with non-discursive understanding existed, it would not be subject to the principle of mechanism (CPJ 5:401–10). I think this line of interpretation is partly correct. The discursive character of our understanding is plausibly a necessary condition for the principle of mechanism to hold for us.

But discursivity is insufficient to account for PM*. First, discursivity does not bear directly on relations between spatiotemporal parts and wholes. While there is a sense in which general concepts contain specific concepts, Kant carefully distinguishes logical containment relations from spatiotemporal part-whole relations.²⁰

Second, the principle of mechanism ranges only over material entities, but no such restriction follows from discursivity. To illustrate, if Berkeley's idealism were true, nothing divisible or movable would be really possible. Nevertheless, minds in Berkeley's world might have general concepts and think general thoughts. For Kant, analogously, finite discursive thinkers could exist without our spatiotemporal forms of intuition. Such thinkers would have a different concept of matter than our own.²¹ Discursivity as such is not modally constrained by our forms of intuition, but PM is so constrained. Discursivity alone cannot account for this constraint.

Third, discursivity holds for a different range of concepts and thoughts than does Kant's principle. All of our concepts and thoughts are constitutively discursive. But not all of our thinking is subject to a demand to explain objects mechanically. We can think about, or conceive of, whatever is merely logically consistent. Such thoughts can have intentional objects where the wholes are prior to parts and cannot be explained mechanically, such as a

¹⁹ Defenders include Allison (2012, 203–4), Förster (2012, 142), Quarfood (2014), van den Berg (2014, 53–87), and Geiger (2022, 119–31); McLaughlin (2014) raises some objections. Kant discusses discursivity at e.g. A68/B93, A230/B283, P 4:318, 4:333, 4:351; 4:356, CPrR 5:137, CPJ 5:484, JL 9:58, and PM 20:325.

²⁰ See FI 20:280, PM 20:411–12, L-Met 28:568–69, 29:979, 29:992, and Sutherland (2022, 210–17).

²¹ See JL 9:36; A230/B283.

pantheistic cosmos or an absolutely simple God.²² In short, if discursivity were sufficient to justify PM, then this principle would have a much broader scope than Kant in fact allows.

Readings based on the mere discursivity of the understanding, though they are right to emphasize that the part-whole content of the principle of mechanism should be traced in part to the understanding, leave out the distinctive spatiotemporal conditions required for determinate cognition of objects. The stage is now set to lay out an interpretation focused on Kant's account of how the understanding makes possible determinate spatiotemporal parts and wholes.

3. PARTS AND WHOLE IN KANT'S FOUNDATIONS OF MAGNITUDE

Kant understands mechanism in terms of the priority of material parts over wholes. I'll now argue that Kant's first *Critique* lays out metaphysical principles that play a key role in grounding the Principle of Mechanism.

The *Critique* articulates a principle for the part-whole structure of all appearances in space and time. Kant considers this as fundamental to the "metaphysics of nature."²³ Yet this principle also plays a role in showing how mathematics is possible (since his foundations of mathematics rely on part-whole relations), and that mathematics is applicable to appearances (since part-whole relations of appearances and mathematical objects share structural features). This complex project, which I label Kant's *foundations of magnitude*, is partly based on the categories of magnitude, which like the other categories are "given...a priori, by means of logic" (P 4:312). Kant's Humean and pantheist opponents accept logic, and he also thinks they accept basic mathematics (CPrR 5:13). He concludes that they ought to grant his claims about the foundations of magnitude. Here I focus on the metaphysical implications of the foundations of magnitude for material objects, and do not attempt to defend his basic assumptions.

The Kantian thesis I'll start with is that all appearances contain parts, in the following sense:

(ACA) All appearances contain "aggregates (multitudes of antecedently given parts)"
(A163/B204)

Let's go through the key terms here. *Appearances*, in the context of Kant's transcendental idealism, include perceived spatiotemporal particulars such as hands and ears, but also matter

²² See Bxxvi(n.); A443/B471; P 4:349(n.).

²³ MFNS 4:469. See also A127; A136/B175; MFNS 4:475n.; and for a sustained investigation, Sutherland (2022).

itself.²⁴ Although appearances per se are “undetermined object[s],” such that the appearance of an object to me need not involve my determinate cognition of it, Kant holds that only appearances can become objects of determinate theoretical cognition, and even equates appearances with empirical objects in some passages.²⁵ Appearances are partly based in the causal affection of our sensible capacities, but also depend on the pure forms of intuition: space and time. What’s more, all appearances “contain” (*enthalten*) aggregates insofar as they contain “an intuition in space and time.”²⁶ This containment must not be understood in the sense that a whole might be said to contain its parts. Instead, Kant speaks of considering each appearance *as* an aggregate.²⁷ Spatiotemporal aggregates would then be metaphysical constituents or aspects of appearances. But they are not the only such constituents: in addition to intuition, an appearance also includes sensory content, which is not an aggregate.

Aggregates, in turn, are composites of determinate, finite parts. As stated in ACA, the parts of aggregates are *antecedently given*. This is a tricky point: determinate aggregates may depend on “progressive decomposition” if parts are carved out of an indeterminate spatial manifold (A524/B552). So the claim that parts of aggregates are antecedently given is a claim about the parts’ metaphysical priority, on the assumption that an aggregate has come into being. But temporal priority may run in the opposite direction, since an indeterminate manifold can exist before such acts of decomposing synthesis. Once an aggregate exists, then, its parts are metaphysically prior in that as they do not depend on the whole for their existence, or on one another, but can “exist for themselves apart from...connection,” or can be “presented separately.”²⁸ The parts can survive rearrangement into a different whole, and if they are scattered, they may persist even though the whole they formerly composed ceases to exist.²⁹ Since these parts are finite, they are discrete and in principle countable: for example, thirteen coins in a pile (A170/B212).

To establish ACA, Kant appeals to a still more basic principle: which he calls the *Principle of the Axioms of Intuition*. As a principle of the pure understanding, this is a

²⁴ See P 4:286; A44/B61; A277/B333.

²⁵ A20/B34; A240/B299.

²⁶ B202. See also B207–8; CPJ 5:250; L-Met 28:562; 29:863.

²⁷ See A163/B203 (“every appearance as intuition is an extensive magnitude”); 4:309 (“appearances, as mere intuitions that fill a part of space and time, are subject to the concept of magnitude”); and a telling revision at Refl 18:660 (“all objects of the senses ~~are~~ have extensive magnitude”). See also Klemme (1998, 250).

²⁸ L-Met 29:825; 28:1038; see also A351–2; NTM 2:286. And see for discussion Engelhard (2005, 385–95); Sutherland (2022, 95).

²⁹ B201n.; L-Met 28:1038.

condition for all possible spatiotemporal objects and hence a universal law of nature.³⁰ Although this principle officially applies the three categories of quantity to spatiotemporal particulars, it is also fundamental to Kant's account of determinate spatiotemporal parts and wholes. Taking a closer look at this principle, and its role in the derivation of ACA, will indicate how an account of material parts and wholes flows from Kant's foundations of magnitude.

The connection to parts and wholes is not immediately evident from Kant's final formulation of the Principle of the Axioms of Intuition, which is simply:

(PAI) "All intuitions are extensive magnitudes" (B202).

By considering each of the key terms in PAI, we can unpack its role in justifying ACA.

First, *intuitions* are singular, given, sensible representations. So-called pure intuitions are required for mathematics. For example, a necessary condition for grasping that a straight line is the shortest line between two points is a singular, intuitive representation (P 4:302). But intuitions are also constitutively involved in ordinary perception. Given Kant's transcendental idealism, the objects of perception, such as tables and chairs, are appearances. Since all appearances contain intuition, it follows that whatever holds for intuitions holds to some extent for appearances too. This is made explicit in the first-edition formulation of the principle: "All appearances are, as regards their intuition, extensive magnitudes" (A162). Although PAI ranges directly over intuitions, then, it is not merely psychological. It has implications for the metaphysics of spatial objects.

Next, PAI refers to *magnitudes*. Kant defines a magnitude in the most general sense as a homogeneous manifold, that is, a manifold of items that are qualitatively alike.³¹ Intuitions themselves are magnitudes, and intuitions play a fundamental role in cognizing objects. Kant therefore adds to his definition of a magnitude that through consciousness of a magnitude, it becomes possible to represent an object. For example, the possibility of representing a house as having a determinate, objective size involves consciousness of a magnitude through the categories of quantity (B162).

Extensive magnitudes are a species of magnitude for which "the representation of the parts makes possible the representation of the whole (and therefore necessarily precedes the latter)" (A162/B203). Kant also says that the parts of extensive magnitudes are "external to one another," as in the traditional definition of extension as having *partes extra partes* (MFNS

³⁰ P 4:306. On this principle, see Klemme (1998, 254–58), Longuenesse (1998, 285–91), Schliemann (2010, 99–117), and Sutherland (2022, 29–86).

³¹ B203; B162; A720/B748; P 4:301–302; L-Met 29:991–92; and for discussion Anderson (2015, 226–31) and Sutherland (2022, 199–209).

4:494). This can again be illustrated by Kant's example of a house. The representation of the house as a determinate object must be generated out of spatial parts, even if we are not explicitly conscious of this.³² These parts are external to one another, and Kant says they are both ontologically and temporally prior to the representation of the whole.³³

Now we can begin to sketch how Kant would derive ACA from his foundations of magnitude. We've seen that outer appearances, such as tables and chairs, always *contain* intuitions. In turn, intuitions are extensive magnitudes. Now, extensive magnitudes are defined as those magnitudes that are composites of antecedently given parts. Aggregates are also defined as composites of antecedently given parts. Therefore, I take Kant to hold that every extensive magnitude is an aggregate.³⁴ These commitments can be put together in syllogistic form:

(P1) Every intuition is an extensive magnitude (by PAI);

(P2) Every extensive magnitude is an aggregate (by the definition of 'extensive magnitude');

∴ (C) Every intuition is an aggregate.

In other words, from PAI and the fact that part of the definition of extensive magnitudes is that they're aggregates, it follows that all intuitions are aggregates. From this conclusion, in turn, it is easy to derive ACA. As we've established, Kant holds that every appearance contains (an) intuition. From this plus the conclusion that every intuition is an aggregate, it follows that every appearance contains an aggregate—in other words, ACA.

To understand the scope and significance of ACA, let's begin with two negative points of clarification. First, Kant does not conclude that all material things are mere aggregates, that is, mere multitudes of antecedently given parts. We can only conclude that material things *contain* aggregates, or can be construed in at least some respect as aggregates.³⁵ So Kant's foundations of magnitude do not entail that all generation of material things and their forms is actually fully determined by those things' material parts and their properties. This is as it should be, if ACA is to help ground PM. If ACA had such strong consequences, Kant would be in a position to endorse a straightforward metaphysical claim about mechanism, rather than

³² Also see A99, B201n., A162/B203, P 4:303n., and PM 20:271. For further details, see Longuenesse (1998, 249–271).

³³ How the parts can be prior is a well-known puzzle. For Kant, material parts need not exist prior to acts of division. See Jauernig (2022) and Sutherland (2022, 98–120).

³⁴ Any aggregate that's a magnitude is also an extensive magnitude. However, some aggregates might fail to be magnitudes at all. Magnitudes are by definition qualitatively homogeneous, whereas an aggregate may be heterogeneous (B162; B203; Sutherland 2022, 200).

³⁵ See further Plaass (1965, §3.2.2.2; §5.51).

a normative principle such as PM. In particular, he could conclude that “all generation of material things is possible in accordance with merely mechanical laws” (5:387). Instead, he says that this claim is unprovable.³⁶

Second, ACA holds for all appearances, but need not hold for all *objects of experience*. It only grounds the possibility of the objects of *outer* experience, that is, spatial objects (A165–6/B206; A158/B197). The distinction between mere appearances and objects of experience is as follows. When a rainbow or a hallucination appears to me to have a determinate size and location, I need not judge this appearance to be true. ACA holds even for these appearances, since appearances involve the representation of parts and wholes, and the definition of extensive magnitude requires only that representing parts makes possible the representation of the whole. As for objects of experience, they must conform to general and necessary laws through determinate, explicit application of the categories of the understanding (P 4:337; B142). Since Kant’s Principle of Mechanism expresses norms for scientific inquiry rather than conditions on all spatial representation, it concerns objects of experience. Kant’s restriction on ACA therefore means that, for the purposes of science, only *outer* objects of experience need be assumed to contain aggregates. If there is inner experience, it is left open whether all of its objects contain aggregates.³⁷ This is also a desirable consequence. As I argued in the previous section, an interpretation of the grounds of PM should explain why its scope is restricted to material objects, rather than applying to objects in general. The explanation is that the objective consequences of ACA are limited to outer spatial objects, rather than applying to all objects of discursive thought. Likewise, PM ranges only over material entities, broadly construed.

I’ll now argue that the consequences of ACA, along with norms of rational inquiry that Kant accepts, can justify PM*.

The objects of outer experience are material things, in the broad ‘transcendental’ sense discussed in the previous section (MFNS 4:481). So it follows from ACA that all outer, material objects of experience are at least partly constituted by an aggregate, that is, by parts

³⁶ CPJ 5:179–80; 5:186; 5:361.

³⁷ See B203, CPJ 5:250; L-Met 28:562; 29:863. If Kant does allow inner experience, a plausible reason for this restriction is that objects with spatial properties be perceived as real, divisible substance, or *real* aggregates (CPJ 5:421; MFNS 4:468n.; 4:481; 4:503). The purely temporal objects of inner perception cannot be real aggregates (B278; B291; A443/B471; 2:194; see further Kraus 2020). Another motivation may be that if ACA’s consequences weren’t restricted to outer objects, they’d interfere with the workings of pure practical reason. For pure practical reason affords inner experience independent of *all* intuition (CPrR 5:31; 5:45; 5:54–56; 5:65). The objects of this experience are not “assembled [*zusammengesetzt*] from” any spatial or temporal “manifold within” them, suggesting they are not in the purview of ACA (5:104).

that are antecedent to or prior to the wholes they compose. Now if we consider any particular material whole W , a disjunction will follow from ACA. Either

(W1) W is fully constituted by an aggregate (it just is a mere aggregate),

or

(W2) W is partly, but not fully, constituted by an aggregate.

Without further evidence, we cannot rule out option W1, on which W is a mere aggregate. But Kant defines a mere aggregate as an entity that is fully determined by its parts. So from ACA, it follows that

(Det) For any particular material whole W , either W is fully determined by its parts, or W is partly determined by its parts.

ACA gives a priori justification for Det. Since apriority implies necessity for Kant, Det is necessary and cannot be defeated by empirical evidence. Det excludes the possibility that W is in no way determined by its parts and properties. Moreover, absent countervailing evidence that would conclusively rule out the first disjunct, Det entails that W is *possibly* a mere aggregate, fully determined by its parts—like a stone or lump of soil.³⁸ This may explain a suggestion that our default “concept of nature” is one of mere mechanism (CPJ 5:246). As a descriptive claim, however, Det does not explicitly tell us how we should explain material wholes or judge them as possible.

Now Kant’s norms of theoretical inquiry come into play. We rationally ought to seek a unified, systematic whole of cognition that includes both a priori and empirical laws (A645/B673; MFNS 4:468–69). An initial step to bring about this end is to subsume the material whole W under empirical laws. Assume that we don’t yet know which empirical laws these are. To guide our search which empirical laws apply to W , we must adopt some principles or policies of inquiry. Since Det is a necessary truth about W , these principles must be consistent with Det. The principles must therefore allow that W is at least partly determined by (and so at least partly explainable in terms of) its parts, and that W is possibly entirely determined by its parts (and so possibly fully explainable in terms of them). It follows that it would be epistemically impermissible to seek to explain W as if it were not determined by its parts at all—for example, to explain it purely by final-causal laws. A normative epistemic principle, then, tells us to seek a lawlike explanation of W , such that W is either

³⁸ Conclusive evidence against the first disjunct is hard to get, because Kantian matter is always further divisible *ad indefinitum*. Any putative discovery that some feature of W is not wholly determined by W ’s known parts might be overturned when still smaller parts of W are observed. This point cuts both ways, though. Any merely mechanical explanation of W will also refer to some lowest scale of parts. There will always be further parts to investigate mechanically. No mechanical explanation, then, will be complete or final (A509/B537; Jauernig 2022, 211).

partly or fully explained in terms of its parts. For this norm to be legitimate it must be the case that, as Det states, a full explanation of *W* in terms of its parts is possible.³⁹

This brings us close to PM*, which is a normative principle guiding our search for empirical laws and which states that we must judge all generation of material things and their forms as *possible* in accordance with merely mechanical laws. Close—but some salient differences remain. PM* refers not just to parts, but to their *properties*. We saw that these properties include forces and the capacity of the parts to combine. I'll now suggest how this gap might be closed—with the caveat that Kant's views on force and composition are more involved than I can do justice to here.

First consider forces. ACA and its consequences do not settle whether material things are in causal relations to one another. Rather, they only show that material wholes are at least partly determined by prior material parts. A part of an aggregate, for example a part of a geometrical figure, might not exert any force at all. Nevertheless, I take Kant to assume that if some *Xs* have metaphysical priority over *Y*, then the properties of the *Xs* also have metaphysical priority over the properties of *Y*. To use Kant's example, the properties of coins in a pile have priority over the properties of the pile. Causal relations are one such property: if the parts stand in causal relations, then the causal relations of the whole are either partly or exhaustively determined by the casual relations among the parts. Kant thinks all matter stands in mutual causal relations of attraction and repulsion, so he thinks the antecedent of this conditional is true. As such, the causal relations of a material whole are at least partly determined by the casual relations among its parts. To illustrate, the *Foundations* contends that matter's attractive and moving forces are determined by matter's magnitude, or mass, and also that matter's magnitude is an extensive magnitude: that is, it just consists in an aggregate of prior parts. This is not a complete mechanical account of the forces of material composites. For example, it leaves aside differences in degree of repulsive force that explain variations in density.⁴⁰ Still, Kant concludes that powers and forces of a material whole cannot be entirely

³⁹ CPJ 5:408 affirms the possibility, in some general sense, of such explanation. But this may turn out practically impossible *for us*: see the previous footnote and the 'grassblade' passage at 5:400. One might wonder how this is consistent with an ought-implies-can principle. A brief remark on this difficult topic: Kant sometimes adds the proviso that we are only required to pursue merely mechanical explanation "as far as" we are able, dodging a direct ought-implies-can violation (5:388; compare MM 6:409). This proviso raises another question, however. Why assume we can pursue merely mechanical explanation at all? If we're simply unable to pursue mechanical explanation (whether specifically for organisms, or generally), the requirement to pursue it as far as we're able is vacuously satisfied. I take my account to help answer this question. See also Watkins (2019, 158).

⁴⁰ MFNS 4:524. Kant seeks to understand why the mass of two bodies is additive but their density is not. On further details, see Warren (2017).

“independent” of its “aggregate” of parts, in line with the strictures given by PM* (MFNS 4:539).

Second, consider the capacity of parts to combine. A necessary condition for physical composition of parts is that these parts can be added together as extensive magnitudes (MFNS 4:489; B288). This is ensured by Kant’s foundations of magnitude, and notably by ACA. Physical composition also requires connection by reciprocal forces (B112; A215/B261–62). But if parts could not metaphysically compose into unities, then further forces would not be able to bring about composition.

To conclude, Kant’s foundations of magnitude and their consequences can satisfy McLaughlin’s demand for an argument for PM* based on premises internal to Kant’s system. This interpretation has further exegetical advantages. It helps us see why Kant makes such persistent references to parts and wholes in his discussions of mechanism. And it avoids problems that plague two standard accounts of the origins of Kant’s principle of mechanism. Now, McLaughlin also called for a *compelling* argument. One could certainly question the premises of the argument reconstructed here, and I haven’t sought to defend them. What has emerged is that for better or worse, these premises lie deep in Kant’s system—in his foundations of magnitude.⁴¹

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