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Hypotheses in Kant's philosophy of science

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ABSTRACT

In this paper I extend the case for a necessitation account of particular laws in Kant's philosophy of science by examining the relation between reason's hypothetical use in the Appendix to the Transcendental Dialectic and the legitimate hypotheses identified in the Doctrine of Method. Building on normative accounts of reason's ideas, I argue that reason's hypothetical use does not describe the connections between objects and their grounds, which lie beyond the reach of the understanding, but merely prescribes the relations between appearances and their conditions, for which the understanding must seek. A legitimate hypothesis, I suggest, is a proposition we hold to be true that fills in one or several of those relations. The problematic character of hypotheses requires that we evaluate our reasons for holding them to be true. While natural modality is grounded in the nature of things, which cannot be fully known, our reasons for assent can and must be grounded on features of objects that are epistemically available to us.

1. Introduction

What distinguishes a law of nature from a generalization about natural facts? The necessity we typically associate with a natural law is not satisfied by a proposition that merely tracks a natural process (all observed *x*s have *P*). It is satisfied by a proposition that presents a governing relation, which contains a robust modal thought (if *X* were the case, then *Y necessarily* would be the case). This modal thought separates accidently true generalizations, such as 'all trees in Jane's garden are jacarandas', from laws of nature, such as 'jacaranda seeds grow into jacaranda trees.' If I were to throw any old seed into Jane's garden, and if that seed were to grow, it wouldn't necessarily be a jacaranda. Yet if I were to throw a jacaranda seed in Jane's garden, and if that seed were to grow, then it would, necessarily, be a jacaranda.

The modal thought that characterizes laws of nature is captured by W. E. Johnson's (1924, pp. 4–5) separation of 'universals of fact' from 'universals of law'. For Johnson, universals of fact take the form 'all *X*s are *Y*s'; for example, all metals expand when heated. Universals of fact entail a logical form of necessity that analytically follows from a concept. Universals of law, in contrast, take the form, 'If anything of some given kind were characterized as *X*, it would be characterized as *Y*'; anything, being metal, *would* expand if it *were* heated. In contrast to logical necessity, universals of law carry what Johnson terms 'nomic' necessity. The grammatical shift from universals of fact to universals of law extends the range of the law into the modal realm—from the actual to the possible—which implies a shift from epistemology to metaphysics. This raises a puzzle for philosophers of science. If natural laws are determined metaphysically, and if scientific method begins with experience, how can we come to know them?

In his critical philosophy, Kant advances a radical account of the epistemology and metaphysics of the laws of nature. *Critique of Pure Reason* (1781/7) outlines a new conception of epistemology in which human cognition prescribes certain laws to nature that make it the case that objects are structured in a determinate way. The law that 'everything that happens has its cause' (A9/B13) is transcendentally necessary, for any relation between two states we call a 'happening' (that is, any change in an object) presupposes the concept of the relation of cause and effect.[1] Yet as Kant argues in *Metaphysical Foundations of Natural Science* (1786), it is also nomically necessary, for the synthetic application of causality to all possible objects entails that it has the metaphysical correlate, 'every change in matter has an external cause' (*MF* 4:543). The correlate is nomically necessary, for it is necessarily true for any possible change in material nature. The determination of every change for cognition does not merely track regularities that happen to hold in nature. It tells us how

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[1] References to Kant's works refer to the volume and page number of *Kants gesammelte Schriften*, Akadamie Ausgabe. They are given in text using the following abbreviations: *MH* = *Metaphysik Herder*; *ML* = *Metaphysik L*; *BL* = *Blomberg Logic*; *VL* = *Vienna Logic*; *Jäsche Logic* = *JL*; *MF* = *Metaphysical Foundations of Natural Science*; *P* = *Prolegomena to Any Future Metaphysics*; *CPJ* = *Critique of the Power of Judgment*; *PG* = *Physical Geography*. Citations to *Critique of Pure Reason* follow the customary A/B pagination. Where possible, translations are taken from the Cambridge editions noted in the reference list.

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effects are posited through a cause. Kant thus vindicates knowledge of the laws of nature by grounding them in the conditions of possible experience.

While Kant's critical philosophy ensures that the epistemic and metaphysical dimensions of natural laws converge, it seems to do so by constraining natural laws to an extremely narrow scope. The concept of causality does not establish the particular cause for a change in nature any more than it establishes that the cause appears in a series of causes and effects. It simply establishes that for every change in nature there *is* a cause, thereby providing the form in which happenings take place (*X* is the cause of *Y*). In the B edition of the Transcendental Deduction, Kant states that while it is (nomically) necessary that there are particular laws, the particular laws themselves are contingent. They concern 'empirically determined appearances', and thus they '**cannot** be **completely derived** from the categories, although they all stand under them. Experience must be added in order to come to know particular laws **at all**' (B165). Kant's point is that the capacity to discriminate between accidently and necessarily true generalizations is not a constitutive feature of experience. Particular laws 'stand under' the categories to the extent that they adhere to the cause-effect template anticipated by the understanding. Yet the categories do not determine the content with which the template should be filled. Thus, Kant is committed to the following claims:

1. there are particular laws (*MF* 4:468, 4:534, *P* 4:318, *CPJ* 20:203–205, 5:180–181);
2. laws involve necessity (A113, A159/B198, *CPJ* 5:184–185);
3. necessity cannot be obtained empirically (A1, B3, B124).

Since particular laws cannot be derived from synthetic *a priori* laws, but are obtained empirically, in what sense are they laws? Three answers have consolidated in the literature, which are often described as the derivation account (DA), the best system account (BSA) and the necessitation account (NA). What is striking in the debate is that each account offers a distinct and mutually incompatible interpretation of the natural modality of particular laws. According to the DA, particular laws are grounded in the categories. According to the BSA, they are grounded in the systematic reconstruction of laws. And according to the NA, they are grounded in actual entities.

In what follows I extend the case for the NA by examining the relation between reason's hypothetical use in the Appendix to the Transcendental Dialectic and the legitimate hypotheses Kant identifies in the Doctrine of Method. I argue that proponents of the NA are right to claim that the modality of particular laws is grounded in actual entities. Yet in contrast to scholars who conclude that particular laws are therefore epistemically unavailable to us (Kreines, 2009; Messina, 2017), I contend that hypotheses form an indispensable part of a scientific procedure by which laws can be known. Building on recent normative accounts of reason's ideas (Breitenbach, 2018; Engelhard, 2018; Massimi, 2017), I argue that the hypothetical use of reason does not describe the connections between objects and their grounds, which lie beyond the reach of the understanding, but merely prescribes the relations between appearances and their conditions, for which the understanding must seek. A legitimate hypothesis, I suggest, is a proposition we hold to be true that fills in one or several of those relations, thereby directing the understanding to seek new observations or experiments against which the rule can be tested. The problematic character of hypotheses requires that we evaluate our reasons for holding them to be true. While natural modality is grounded in the nature of things, which cannot be fully known, our reasons for assent can and must be grounded on features of objects that are epistemically available to us.

2. Accounting for particular laws

In this opening section I provide a brief overview of the criticisms levelled against the three accounts of particular laws in Kant's philosophy of science. My aim is not to provide an exhaustive assessment but to discern the minimum requirements for a satisfactory account.[2]

2.1. The derivation account

The DA is based on the claim that the necessity of particular laws is grounded exclusively in the transcendental laws of the understanding. Friedman (1992a, p. 163), normally held as the main advocate of this view, claims that particular laws, insofar as they merely record observed regularities, 'are contingent and *a posteriori*.' However, insofar as they 'subsume such regularities under the *a priori* principle of causality … they are necessary—and even, in a sense, *a priori*.' *A priori* particular laws can be broken down into two further kinds: the laws of mechanics, which are derived by applying the transcendental laws to the empirical concept of matter (*MF* 4:496; c.f. *P* §38), and mixed particular laws, which require content beyond the empirical concept of matter (*MF* 4:518; c.f. A662–663/B690–691). Kant's derivation of the law of gravity provides the clearest example of a mixed particular law, for it is discovered after a process of reflecting on the sensory manifold (see Friedman, 2014, p. 536). Both classes of particular law are nomically necessary to the extent that the transcendental laws are 'injected' into them (Friedman, 1992a, p. 175), meaning that they govern how nature *must* behave.

The upshot of the DA is that, beyond the pure and mixed laws of Newtonian science, 'the rest of the phenomena of nature—chemical phenomena especially—remain entirely unaccounted for' (Friedman, 1992b, p. xv). The laws produced by the experimental sciences merely track empirical phenomena and cannot be said to govern them, and are better described as lawlike regularities that approximate categorial determination (see A647/B675). Friedman (1992a, p. 164) concludes that beyond the pure and mixed particular laws, 'Kant is in basic agreement with Hume: they [the so-called particular laws] are established by induction and by induction alone.' By 'induction' Friedman means enumerative inferences of the following kind: 'All observed *X*s have property *P*; therefore, the next *X* will have *P*.' Such inferences shift from observations to a lawlike proposition that does not have a natural modality.

The DA has been criticised for leaving two problems unsolved. The first is a *textual problem*: it does not adequately explain Kant's description of particular laws *as laws*, including chemical laws (*MF* 4:468, 4:534, *CPrR* 5:26, *P* 4:318). While Friedman insists that we should read 'law' as 'law*like*', Kant regularly insists that generalizations are unlike laws and that particular laws possess nomic necessity. The textual problem, if one buys it, points to a deeper *problem of inference*, which critics have modelled on van Fraassen's critique of Armstrong's necessitarian account of laws (Massimi, 2017, pp. 150–151). While the DA demonstrates how pure and mixed particular laws govern possible objects of experience, it does not explain how they necessitate the empirical goings-on of nature (Engelhard, 2018, p. 28). Laws are not causes, for they do not appear in space and time, so they cannot act on spatio-temporal things. Thus, there is no legitimate way to infer from the necessity of possible objects to the necessity of empirical goings-on. While the transcendental laws make it the case that there is a causal relation that necessitates a determinate time-order, and while the application of those laws to the empirical concept of matter demonstrates that every change in matter has an external cause, the DA does not explain how we are warranted to transfer the necessity of nature in general to the necessity of actual objects.

2.2. The best system account

Advocates of the BSA accept that, on the basis of the Transcendental Analytic and *Metaphysical Foundations*, Kant determines the transcendental laws of the understanding and a set of particular laws that derive

[2] For comprehensive examinations of the debate, see Messina (2017) and Engelhard (2018).

from them. Yet instead of casting the remainder of particular laws as inductive generalizations, they argue that Kant's philosophy of science includes a lower-level of particular laws that are not grounded in higher-level transcendental laws but in the consilience of a law with other laws in the best system of natural science (Buchdahl, 1965, pp. 201–202; Kitcher, 1986, pp. 204–215; Butts, 1986, pp. 179–187; Guyer, 1990, pp. 39–43).[3] When the deduction of a law is foreclosed, judgment follows the principle of purposiveness to generalize from experience to approximate a rule (*CPJ* 5:180). Yet because the categories do not prescribe how natural objects behave, something else is required to 'inject' necessity into candidate lawlike propositions.[4] This injection comes from the systematizing function of reason, by which a generalization can 'accrue' necessity if it consistently and interdependently finds its place in the best system of lawlike statements. Generalizations can be 'regarded as necessary' by virtue of the position they take in the best system of laws for our world (Kitcher, 1986, p. 209).

The BSA solves the *textual problem*, for it explains how particular laws can be regarded as laws. The necessity of empirical nature is located in the laws understood as elements of a system. It does not, however, solve the *problem of inference*, for the necessity of particular laws is not grounded in the categories but rather in reason's interest in unity. This can be expressed as a *direction-of-fit problem*. By separating the necessity spontaneously determined by the understanding from the necessity accrued by reason's systematicity, the BSA results in a situation in which the necessity of particular laws has no purchase on nature.[5] If a law supervenes on the occurrence of some fact then it does not explain the occurrence of the fact. Rather, the occurrence of the fact explains the law. This is to say that particular laws do not determine an effect, but the effect determines the law; the direction of explanation goes the wrong way (Engelhard, 2018, p. 30; Messina, 2017, p. 136). The problem with the BSA is that the systematic unity of our laws cannot explain how they necessitate or govern spatio-temporal events in nature. Empirical inquiry approximates to the kind of universality that knowledge seeks.

2.3. The necessitation account

Like the BSA, the NA agrees with the DA to the extent that pure and mixed particular laws are grounded in the categories. Yet in contrast to the BSA, which calls on the systematicity of reason to inject necessity into lower-level empirical generalizations, advocates of the NA argue that 'the lawfulness of appearances is more than just a projected or injected lawfulness' (Massimi, 2017, p. 168). Advocates of the NA separate the metaphysical question of grounding from the epistemic question of knowledge, and claim that to be a law does not require derivation from the categories (Messina, 2017, p. 138). A particular law is a proposition that identifies 'a kind on whose nature some regularity depends, in the sense that it is *necessitated* by the nature of that kind' (Kreines, 2009, p. 528). Particular laws can thus be described as categorically contingent and yet metaphysically necessary (Stang, 2016, p. 228). There are several ways of introducing the metaphysical idea in the literature. Watkins (2005, p. 244) rejects event-event causation as an adequate understanding of Kant's view, and proposes a version of the NA according to which substances have natures that confer a certain causal power if certain conditions are obtained. Stang (2016, p. 229) draws from Kant's lectures on metaphysics to frame a similar idea in terms of essences. Engelhard (2018, p. 8) defines the properties that are relevant for scientific explanations in terms of dispositions. Each presentation shares the view that the lawfulness of particular laws is not injected into empirical generalizations from above, nor projected on them by the best system of laws, but grounded from below.

Proponents of the NA often draw on student notes taken from Kant's lectures on metaphysics to fill in some of the details of his critical account of particular laws. In these notes, Kant is recorded as separating logical from real grounds in a manner that anticipates Johnson's distinction between universals of fact and universals of law. In the Herder notes (1762–4), for instance, Kant defines a ground as 'something by which, having been posited, something else is posited' (*MH* 28:11). A ground is logical when the relata of a grounding relation are identical, that is, something is a logical ground of something else if the concept of the former contains the concept of the latter. A ground is real when the relata of a grounding relation are non-identical. If a real ground is posited as a *cause*, a consequence follows as something non-identical, namely, an *effect*. A real consequence does not follow logically but existentially from its ground. Thus, while particular laws are categorically contingent, they are nevertheless nomically necessary: their necessity is determined by their essence (Stang, 2016, pp. 228–229), the nature of their kind (Kreines, 2009, p. 528). The cause of a change is the exercise of the disposition of a thing's nature. Regular occurrences in nature happen because natural things have natures with certain causal dispositions (Massimi, 2017, p. 157).

The NA thus solves the *textual problem*, for it explains the sense in which particular laws are necessary: they are grounded in the properties of objects or relations between those properties in nature. It also solves the *problem of inference*, for it explains how laws govern natural processes. Moreover, it solves the *direction-of-fit problem*, for it demonstrates how Kant's metaphysical determination of particular laws alleviates the worry that particular laws supervene on natural facts. On the NA, Kant does not simply vindicate the objective sequence of events in experience but also the objective determination of natural properties according to laws. At several points in the Transcendental Analytic Kant seems to have this view of causation in mind. He claims that the connection between cause and effect means that the effect does not merely 'come along with' the cause but is rather 'posited **through** it and follows **from** it' (B124).[6] Particular laws are nomically necessary, not on the transcendental level of possible objects but on the metaphysical level of actual objects. This is to say that the real cause must give the modal strength of a law, not the category of causation. On the transcendental level, we have knowledge of the causal connection between successive states of an object because we represent those states as 'standing under' a categorical law. To attribute a law to a substance, however, is to say that all instances of that substance possess the same property. This expression carries nomic necessity.

Kreines (2009, p. 536) and Messina (2017, p. 138) argue that because the necessity of particular laws is grounded metaphysically—in the nature of things, which cannot be fully known—particular laws are epistemologically unavailable to us. On their rendering of the NA, the epistemic unavailability of particular laws is a trade-off the transcendental idealist must accept for gaining knowledge of transcendental laws and the pure and mixed particular laws identified by Friedman. Critical philosophy simply rules out essences as the grounds for our knowledge claims. As Kant states in his lectures on metaphysics, '*the real essence of things is inscrutable to us*, although we cognize many essential aspects' (*ML* 28:553). The problem here is that once the metaphysical grounding of particular laws

[3] 'Best system' can be a misleading term to use in relation to Kant, for both 'best' and 'system' are ambiguous in the contemporary literature. Ramsay considers the best system as a fully deductive system of things we know; a system is 'best' if its simpler than alternative systems. For Lewis, the best system is a system of both particular and general truths, but it is not necessarily deductive; the 'best' system has the pragmatically best trade-off between simplicity and informativeness.

[4] Like Friedman, Buchdahl (1969, pp. 508–509) uses the metaphor of 'injection' to explain how generalizations take on necessity. However, on his account it is the place the law takes within the best system that injects necessity.

[5] For example, consider some of the formulations offered by Buchdahl (1965, p. 204, 206): 'the necessity of laws must itself be regarded as a pure function of the regulative employment of reason'; 'the lawlikeness of laws must be made dependent on reason and not the understanding.'

[6] The very next sentence, however, denies that strict universality can be a property of empirical rules. They bear merely comparative universality. Kant's point, I take it, is that lower-level particular laws are specific to certain natural kinds.

has been separated from the epistemic conditions of experience, metaphysics cannot be straightforwardly reconnected with experience without returning to the stormy ocean of illusion. Reason's ideas, according to Kreines (2009, p. 536), can only legitimately be deployed as 'guiding' or 'methodological' principles, which direct the understanding to search for the sameness of kind within the empirical manifold:

> Our guiding principles might direct us to single out, for example, the rule or statement 'salt is water soluble'. But such guidance falls short of establishing *knowledge* of a law; rather, we regard the general rule as a law *for the purposes of further research*. … we have made a real advance, and we do have reason to conclude that our theories are improving or that we are making progress, or that we are improving in approximation to knowledge of particular laws. (Kreines, 2009, p. 536–537)

On Kreines' version of the NA, the principles of reason cannot 'inject' necessity into lawlike generalizations, as the BSA would have it. Neither can they provide 'any justification for concluding that we have reached particular laws' (Kreines, 2009, p. 537). Rather, 'guiding principles allow us to single out and "think as laws" the empirically known rules, specifically for the reason Kant emphasizes: without doing so we could make "no progress" in investigation of the particularities of nature' (Kreines, 2009, p. 537). Kreines characterizes the search for particular laws in terms of approximation. Empirical inquiry requires that we 'assume' that there are natural laws governing distinct kinds, and yet we can only 'improve our approximation to knowledge of them' (Kreines, 2009, p. 542).[7] The idea is that while reason instructs us to assume that there *are* particular laws, those laws, by their very nature, lie beyond the scope of cognition. There is a gap between cognition and those laws, which we seek to traverse asymptotically. Yet there is nothing that could guarantee the correspondence between our approximation and the law.[8]

While the version of the NA defended by Kreines and Messina makes headway in solving the problems left open by the previous views, several recent studies have claimed that it opens an additional *epistemic problem* (Breitenbach, 2018; Engelhard, 2018; Massimi, 2017). The problem begins as a textual worry: Kant seems to take it for granted not only that there are particular laws, but also that we are acquainted with them. Consider an example from the first *Critique*: 'the sunlight that illuminates the wax also melts it, though it hardens clay' (A766/B794). Kant explains that while we know *a priori* that any change undergone by a substance has a cause, the 'understanding could not discover let alone lawfully infer from the concepts that we antecedently have of these things, and only experience could teach us such a law.'[9] While Kreines and Massina establish that the NA entails the epistemic unavailability of particular laws, there are strong textual reasons to question whether the inference is shared by Kant.

Massimi, Engelhard and Breitenbach take the Kreines/Messina account as the point of departure for a revised version of the NA. Noting Kant's repeated reference to particular laws in his account of cognition, Breitenbach (2018, p. 113) diplomatically states that it would be 'surprising if our principled ignorance of particular laws were his last word on the matter.' Massimi puts the matter more forcefully. She claims that Kreines' interpretation raises an 'epistemological quandary', and argues that 'we can cognize the necessity of empirical causal laws (which is derived neither *a priori* from the understanding nor *a posteriori* by experience), because these laws "stand under" the formal template of causality, under which only it is possible for us to carve nature's empirical manifold according to modally robust regularities' (Massimi, 2017, p. 169). Similarly, Engelhard (2018) rejects Kreines' conclusion in favour of a dispositionalist account of particular laws. To have a disposition means that a property is essentially linked with a specific causal profile, which confers a causal power (Engelhard, 2018, p. 31). Engelhard (2018, p. 9) concludes that we 'do have full epistemic access to the powers, since we know what they do.'

While I agree that the conclusion reached by the Kreines/Messina version of the NA is unsatisfactory, I suggest that further work needs to be done to earn the epistemological position sketched by the revised version of the NA. Massimi, Breitenbach and Engelhard each identify a kind of 'knowledge' (Engelhard, 2018, p. 9) or 'cognition' (Massimi, 2017, p. 169; Breitenbach, 2018, p. 114) of particular laws, yet their use of these terms is not strictly coterminous with Kreines', who adheres to Kant's formal use of cognition (*Erkenntnis*) as the conceptual determination of a sensibly given object for the definition of both cognition and knowledge (e.g., Kreines 2009, pp. 528–529). Breitenbach (2018, p. 118) provides a sketch of how this distinction might be played out by separating 'strict knowledge' from 'a form of knowledge in the loose sense of the term.' If Kreines' interpretation of the NA is to be rejected, we must identify the grounds for this looser conception of knowledge by demonstrating that reason's ideas can do the very thing he denies: provide 'justification for concluding that we have reached particular laws' (Kreines, 2009, p. 537).

In the following section I argue that the dispute between the Kreines/Messina version of the NA and the revised version defended by Massimi, Engelhard and Breitenbach is not simply textual; it turns on a substantive question of how we interpret the hypothetical use of reason in the Appendix to the Transcendental Dialectic. On the Kreines/Messina account, reason's ideas operate as guiding principles by describing that there are natural kinds with determinate properties, thereby directing us to 'seek in empirical inquiry knowledge of a kind of universality that is independent of the conditions under which we can have knowledge, or out of reach, so that empirical inquiry can only *approximate* to knowledge of the sort of universality that it seeks' (Kreines, 2009, p. 538). The upshot of this reading is that approximation is not a species of truth but rather a form of reasoning that operates independently of the conditions under which we can have knowledge. In contrast, I argue that approximation is an indispensable part of a broader procedure by which particular laws are epistemically available to us. While Kant is clear that approximation is a defective form of truth, for it does not, on its own, provide sufficient grounds to guarantee the truth of the proposition, it is a species of truth nonetheless. The truth of approximation, I suggest, is independent of the Analytic's 'land of truth' (A235/295), wherein a judgment's correspondence with its object is guaranteed immediately. It features within the broader epistemological categories considered in the Doctrine of Method, whereby an objectively sufficient ground guarantees the truth of the proposition for which it is the ground.[10]

[7] Thus, like Friedman, Kreines (2009, p. 538 fn. 28) likens Kant to Locke and Hume: he denies knowledge of real essences and refrains from asserting that there are unknowable particular laws.

[8] Kant's use of 'approximation' draws from the Newtonian tradition of experimental philosophy. Newton argued that in contexts for which mathematical demonstration had not yet been achieved, the natural philosopher must follow an analogical procedure by transcribing the known principles of one kind of thing to another, thereby opening the possibility of new demonstrations. Yet his account of analogical reasoning does not entail that approximations are deficient as a form of knowledge. Newton's third rule instructs the natural philosopher, if the demonstration holds, to regard those approximations as 'accurately or very nearly true' (Newton, 1973, vol. II p. 400). In Section 3 I suggest that Kant has a similar conception of analogical reasoning in mind, though placed in the register of his critical epistemology.

[9] Consider another example from the Introduction to the third *Critique*, where Kant notes that the distinct natures of empirical objects each 'have its rule, which is a law, and hence brings necessity with it, although given the constitution and the limits of our faculties of cognition we have no insight at all into this necessity' (*CPJ* 5:183).

[10] Here I build on Willaschek and Watkins' (2020, p. 3207) important study, in which they argue that the concepts of cognition (*Erkenntnis*) and knowledge (*Wissen*) in the *Critique* are not only distinct but even disjunct. Cognition, they propose, is a species of representation that involves the conceptual determination of a sensibly given object, whereas knowledge is a kind of assent to a judgment that requires consciousness of a sufficient epistemic ground.

3. Resolving the epistemic problem

As Engelhard (2018, p. 25) notes, proponents of the NA tend to reject the BSA for the reason that it proposes an incompatible theory of grounding in Kant's philosophy of science. This is surely correct: the natural modality of particular laws cannot be grounded in both the global character of the best system of laws *and* ultimately local entities (see Kreines, 2009, pp. 529–530). However, the two positions are only incompatible if they are examined as responses to the problem of grounding. Engelhard affirms a version of the NA according to which the modal force of particular laws is grounded in the nature of the kind of thing that something is. Yet she does not conclude that those laws therefore lie beyond the remit of knowledge. Rather, she claims that we require 'a systematisation of the laws to know which of the powers we experience are genuine and which are not' (Engelhard, 2018, p. 33).[11]

In this section I aim to identify *how* such knowledge can be justified by considering an aspect of systematization that has been overlooked by proponents of the NA, namely, Kant's account of legitimate hypotheses and the broader epistemological categories outlined in the Doctrine of Method.[12] In the Appendix, Kant is clear that an idea cannot legitimately describe an object beyond the limits of experience, which is to say that ideas do not project the properties of natural kinds that we must approximate.[13] The only legitimate relation that reason can have to objects is 'indirect', that is, through the empirical use of the understanding (A665/B693). An idea, Kant explains, 'shows not how an object is constituted but how, under the guidance of that concept, we ought to seek after the constitution and connection of objects of experience in general' (A671/B699). The way I propose to interpret this passage is that an idea does not describe antecedently determining grounds, to which our approximations converge asymptotically, but merely prescribes the relations between appearances and their conditions that we seek to fill through a hypothetical procedure.[14] In the Doctrine of Method, Kant defines a legitimate hypothesis as a proposition that stands as a possible property or disposition that is adequate to explain a given consequent, thereby directing the understanding to seek new observations or experiments against which the rule can be tested.[15] Or to use Johnson's modal terms, a hypothesis is a rule through which a consequence *would* be determined if it *were* true. Hypotheses thereby direct the understanding to find out whether the effect flows from the rule, forming what Kant describes in the *Jäsche Logic* as an 'indispensable' part of empirical inquiry, for they make available certain epistemic grounds that can justify our assent to lawful propositions (*JL* 9:86).

3.1. The hypothetical use of reason

In the Appendix to the Transcendental Dialectic, Kant describes reason as 'the faculty of deriving the particular from the universal' (A646/B674). This faculty can be exercised in two inverse ways. If the universal is certain and given, and need only be applied, then 'the particular is necessarily determined through it.' Kant terms this the 'apodictic' use of reason. If the universal is 'assumed only problematically', then it is only the particular that is certain 'while the universality of the rule for this consequent is still a problem.' Kant terms this the 'hypothetical' use of reason. In such cases, we look to several particular cases which are then 'tested by the rule, to see if they flow from it.' When we find that the particular cases *do* flow from the rule, then 'the universality of the rule is inferred, including all subsequent cases, even those that are not given in themselves' (A647/B675).

Kant's account of reason's hypothetical use can be seen as an interjection into the ongoing debate regarding the use of hypotheses in eighteenth century natural philosophy. Many experimental philosophers following Newton rejected the hypothetical use of reason as mere fiction, for it extends beyond the data given in experience by calling on occult qualities. Humean induction does not parade as hypothetical reasoning, according to which a conclusion necessarily follows from its premises. It self-consciously infers from a statement of fact (all observed *x*s have *P*) to a prescriptive conclusion (the next *x* will have *P*). This model of induction is characterized by three elements: (1) the form of the premises is different to the conclusion, (2) the premises do not entail the conclusion and (3) the strength of the argument (the inductive analogue of validity) is a function of the logical relation between premises and conclusion (for example, the ratio between sample size and population size).

In the following subsection I seek to show how Kant's critical epistemology opens an inductive procedure that is (1) hypothetical, for it involves the formulation of hypotheses that explain the consequences that can be derived from them, and (2) legitimate, for it does not call on qualities that are epistemically unavailable to us. To anticipate that account, it is worth noting that Kantian induction differs from Humean induction on all three counts. First, judgments of experience for Kant already contain the form of causation, which does not need to be superadded at some later point of the procedure. This ensures that, in the case of physical hypotheses, the form of the premise coheres with the conclusion. An induction for Kant unifies all *x*s as an idea that contains *P*, and formulates a hypothetical proposition (*Px*). This entails that, second, the premises of a Kantian induction entail the conclusion. Induction is not an inference from one proposition to another, but rather a way of unifying diverse appearances under a single idea, such that we assume the facts to follow from the idea. This leads to the third difference: Kantian inductions are valid, for they follow a modelling or systematizing procedure. An induction creates a new system, or subsection within a system, and further inductions are valid if they can be deduced from a higher level of supporting inductions within it.

3.2. Legitimate hypotheses

If hypotheses extend beyond the scope of what can be given in experience, then the burden lies with Kant to tell us how they are legitimate in natural science. Experimental philosophers were skeptical of hypothetical inferences for a reason: no amount of experience can justify a proposition that contains necessary. This concern partly motivates Kreines' version of the NA, according to which reason's principles merely guide us to approximate knowledge of particular laws without ever purporting to have reached it. To assume the proposition that 'for *x*, necessarily *P*' is to assume a determination beyond what can be established by the categories, for it concerns the causality not of appearances

[11] Similarly, McNulty (2015, p. 4) defends an 'ideational interpretation' of particular laws, according to which the systematization of principles allows us to determine which principle is the ground of a particular judgment. McNulty (2015, p. 9) argues that while the laws of physics must be derived in some way from the categories, there are other laws that 'can be grounded on *other a priori* grounds: reason's ideas.'

[12] Chignell (2007, pp. 323–324) notes that this section has been understudied for a variety of reasons, each reflecting the common mistake of identifying cognition with knowledge. An exception is McNulty (2015, p. 7), who acknowledges the role of belief in scientific knowledge. The dispositions of natural kinds cannot feature as possible objects of experience, he notes, and yet they can have a 'theoretical merit', for they are 'necessary for the achievement of a theoretical system of the understanding's cognitions.' See also Breitenbach (2018, p. 117).

[13] Kant states that 'Reason never relates directly to an object, but solely to the understanding and by means of it to reason's own empirical use, hence it does not create any concepts (of objects) but only orders them and gives them that unity which they can have in their greatest possible extension, i.e., in relation to the totality of series' (A643/B671). See also A670/B698.

[14] Space does not permit a reconstruction of normative readings of reason's ideas. My account builds on Spagnesi's (2022, pp. 12–13) notion of ideas as 'analogues of real things.'

[15] The clearest definitions we find in the critical philosophy characterize hypotheses as 'serving to account for what is given' (A770/B798) and 'the explanation of the possibility of a given appearances' (*CPJ* 5:466). For a systematic account of hypotheses in Kant's writings and lectures, see Pasternack (2014, pp. 67–68).

but of actual objects. To extend the modality of the judgment to all possible instances of a kind (if something *were x*, necessarily *P*) requires a metaphysical determination in the form of a nature or real essence, which cannot be cognized.

Evidently Kant had this concern in mind, for he included a section in the Doctrine of Method entitled 'The discipline of pure reason with regard to hypotheses' that identifies two rules to determine whether a hypothesis is 'worthy of assuming [*Annehmungswürdig*]' in a program of research.[16] The first rule ensures that hypotheses are tethered to something that *can* be known *a priori*:

> If the imagination is not simply **to enthuse** but is, under the strict oversight of reason, **to invent**, something must always first be fully certain and not invented, or a mere opinion, and that is the **possibility** of the object itself. In that case it is permissible to take refuge in opinion concerning the actuality of the object, which opinion, however, in order not to be groundless, must be connected as a ground of explanation with that which is actually given and consequently certain, and it is then called an **hypothesis**. (A770/B798)

A hypothesis worthy of assuming is a proposition, object or state of affairs that stands to account for the cognitions given in experience, that is, when the connection between *X* and *Y* is causal. Call this rule *Real Possibility*:

> Real Possibility: A hypothesis is *really possible* iff it agrees with the formal conditions of experience (forms of intuition and the categories).[17]

Real Possibility entails that assumeworthy hypotheses are *physical* hypotheses, which account for the existence of a consequent by analogy with the 'constitution and connection of objects of experience in general' provided by the categories under the guidance of reason's ideas.[18] Newton's proposal that the arrangement of the planetary system is determined by the wise forethought of God, for instance, fails to adhere to the law of causality (see Newton, 1973, vol. II pp. 399–400). Newton proffers what Kant terms a 'hyperphysical' hypothesis, the direct use of an idea of reason to explain the possibility of an object. To explain a natural phenomenon by deriving from an idea of reason 'would thus be no explanation at all, since that which one does not adequately understand on the basis of known empirical principles would be explained by means of something about which one understands nothing at all' (A772/B800). Such an inquiry might be free of contradiction. Yet it would be without an object, and thus could never be justified according to grounds that are epistemically available to us (see A821/B849). One can decide not to think of nature in causal terms, for it is possible to think outside the categories. However, such a decision would render knowledge-yielding experience impossible, for it would deny that the categories hold in every case.

While Real Possibility defines a narrower field than what is *logically* possible, its field is far greater than what is *actually* possible. Kant provides further definition to the first rule by explaining that legitimate hypotheses must be 'connected to the given appearances by already known laws of appearances' (A772/B800). By 'already known laws of appearances' I take Kant to mean not simply the understanding's laws, which apply universally and necessarily to any possible object, but also the particular laws discovered in the course of experience.[19] To define what is possible in regards to actual objects, experience is required. The formation of opinions must be restricted to what is *empirically* possible, which is thicker than the formal conditions of possibility (see Chignell, 2017, p. 272). Empirical Possibility includes Real Possibility *and* the already known particular laws:

> Empirical Possibility: A hypothesis is *empirically possible* iff its existence agrees with the universal conditions of experience plus the already known particular laws.

This rule places nonlogical constraints on possibility. When we seek the ground of an effect, a hypothesis must be assessed in relation to other pieces of our system of knowledge. The coherence of a hypothesis with that system does not determine the *necessity* of a regular occurrence we discern in experience, as proponents of the BSA claim. The necessity conveyed by a force can originate only in the understanding, which requires that appearances are given causal explanations. Reason's instruction that we seek to minimize the number of forces by searching for a 'sameness of kind' presupposes that there *are* forces; it cannot legitimately produce them (A660/B688). Vanzo (2012, p. 83) illustrates the rule with an example from Kant's lectures on physical geography. To explain the phenomena of earthquakes and volcanoes we could formulate the proposition, 'there are flames at the centre of the earth', which does not fail the first version of the rule (*PG* 9:259–260). A possible world in which the earth consists of a fiery centre is thinkable (e.g., the world presented in Dante's *Commedia*). Given the laws of combustion, however, we know that the existence of flames at the earth's centre is impossible, for combustion requires air. A world in which flames could burn without air would require a very different causal history to that of our own. Given the preceding actual events of *our* world, and the resultant particular laws we have already adopted, the proposition fails the second rule. Within the unique field of empirical possibility, a hypothesis we *can* entertain is that the centre of the world is composed of heated matter (*PG* 9:260; c.f. *JL* 9:85).

The first rule of hypothesizing aids us to see the uniqueness of Kant's method. Before Kant, most philosophers held that to determine given appearances *a priori* is either impossible, for sensibility is distinct from the intellect, or a proposition describing such appearances as logically implied by a law (see Butts, 1961, p. 166). The former implies that empirical science follows an enumerative procedure of induction, for causal connections cannot be established *a priori*. The latter provides a deductive model of explanation. Kant's alternative is that a hypothesis is legitimate when the *relation* between the hypothesis and the appearances is certain. A hypothesis ascribes a rule to all members of a class, despite having only experienced some of them, on the assumption that they share a common ground.[20] This directs us to experience to test the appearance against the rule, to find out whether the hypothesis correctly picks out the cause. For example, the fact that a change in the state of this piece of wax is causally connected to its being in the sunlight provides an instance against which we can test the rule 'the sunlight that illuminates the wax also melts it'. But the fact that the jacaranda tree is in Jane's garden does not provide an instance against which we can test the rule 'all trees in Jane's garden are jacarandas'. The difference between the two cases is that we have warrant on the appearance of melting wax to propose the sunlight as its potential cause (due to the causal connection), whereas we do not have warrant on the appearance of a jacaranda tree to propose Jane's garden as its cause (they are merely simultaneous). Once we have established that the relation between sunlight and the melting wax is one of dependence, we can begin to formulate hypotheses that determine the

[16] Drawing primarily from Kant's lectures on logic, Vanzo (2012, pp. 83–84) identifies *three* rules for legitimate hypotheses: they must (1) offer an explanation for phenomena that actually take place, (2) be testable against the consequences and (3) be sufficient to explain a set of phenomena without requiring further hypotheses. The rules I identify in the following are drawn from the *Critique*, and thus give greater weight to Kant's modal metaphysics.

[17] My formulation of Kant's modal rules draws from Stang (2011) and its application to Kant's doctrine of assent by Chignell (2017).

[18] My characterization of legitimate hypotheses as 'physical' hypotheses draws from Leduc (2013, p. 126).

[19] Here I disagree with Butts (1961, p. 166), who assumes that Real Possibility can be established with the relational categories of the understanding alone.

[20] In *Jäche Logic*, Kant describes induction as an analogical form of inference that moves 'from *many* determinations and properties, in which things of one kind agree, *to the remaining ones, insofar as they belong to the same principle*' (*JL* 9:132; C.f. *BL* 24:287). See Vanzo (2012, p. 82).

change in state through a cause. The key is that while the hypothetical judgment 'sunlight melts wax' may or may not be true, we are entitled to make it because *a priori* sunlight stands as a possible ground of melting wax due to the causal principle.

I assume here that many of the already known laws have not (yet) been demonstrated mathematically, and are thus held for true with various strengths of commitment. In the Introduction to the Transcendental Dialectic, Kant clearly states that if one holds a proposition as probable, then one does not succumb to illusion. Probability, he explains, is 'truth, but cognized through insufficient grounds, so that the cognition of it is defective, but not therefore deceptive' (A293/B349). Probable propositions are not deceptive but defective, for they are adequate to explain a given consequent and yet we do not have sufficient grounds to *guarantee* the truth of the proposition. This entails that a hypothesis that fails Empirical Possibility is not categorically illegitimate. Our current body of knowledge may imply that the hypothesis is not worth assuming, yet Kant was well aware that the history of science is littered with examples wherein new observations exposed false hypotheses, or where a new hypothesis accounted for the consequents so powerfully that one or several accepted hypotheses were cast aside. The fact that the connections within a science *are* explanatory is precisely why we are able to test them against observations and through experiments. Their explanatory character is why we must carefully evaluate the strength of our reasons for holding them for true.

The danger is that a physical hypothesis can very quickly become enmeshed in a network of hypotheses. If we must call on further auxiliary hypotheses to defend an initial hypothesis, the network begins to 'arouse the suspicion of being a mere invention' (A774/B802). To block the proliferation of hypotheses, Kant proposes a second disciplinary rule:

> Adequacy: A hypothesis is worth assuming when it is adequate for determining *a priori* the consequences that are given.

To erase the suspicion of mere invention, we must strive to avoid auxiliary hypotheses and limit our assent to those that are adequate to determine consequences that *are* given. Such hypotheses are at least anchored to something objective. Kant tells us very little about how we might move from a hypothesis that is *adequate* for determining *a priori* the given consequence to judging that it *actually* determines the consequence *a priori*. This suggests that knowledge in the 'loose' sense is not his primary concern in the *Critique*, and requires further reconstruction (see Willaschek & Watkins, 2020, p. 3206). In his lectures on logic we find evidence that Kant held that hypotheses can lead to certainty. In *Blomberg Logic*, for instance, Kant explains that 'when the ground suffices for *all* the determinations but also *not* for more determinations than are contained in the consequence, then there is a true ground, and then *hypothesis* ceases. The ground becomes a *theory*. A certainty' (*BL* 24:221–222). Here Kant implies that a confirmed hypothesis ceases to be a hypothesis. It becomes a theory, or, in the language of the first *Critique*, a particular law.[21] By 'true ground' I take Kant to mean the correct ground, where several possible grounds were available.

McNulty (2015, p. 4) offers a helpful reconstruction of this procedure in the context of chemistry. His reconstruction builds on Kant's account of reason's hypothetical use in the Appendix, where he notes that while we never experience '**pure earth, pure water, pure air,** etc.', concepts of them are required 'in order appropriately to determine the share that each of these natural causes has in appearance' (A646/B674). Kant's point, McNulty explains, is that scientific knowledge of the chemical elements does not occur via an inference from repeated experience to a rule. Rather, to unify the manifold of chemical phenomena, the chemist reduces all the metals to *earth*, and measures their weight, all the salts to *combustibles*, and measures their force, and examines water and air as *vehicles*, measuring their mechanical properties. If reason could not project an idea to which the weights, forces and mechanical properties can be reduced, the understanding would simply give particular earths, particular combustibles and particular bodies of water. By unifying all *x*s as an idea, we can test particular instances of *x* by the rule 'to see if they flow from it', and work toward a system of elements. Of course, the only way to remove the possibility of doubt would be to grasp the system in its entirety, such that the ideas that guide our inquiry become determinate concepts in a system of proper science (the standard set by the DA). Yet as we will see in the following subsection, Kant does not equate knowledge with this standard.

The key to Kant's account of physical hypotheses is that without natural modality—without assuming that there are antecedently determining grounds, which are *a priori* but not synthetic—we would be unable to test an instance against a rule. We cannot anticipate what these properties are, which is precisely why experience is required. We formulate hypotheses by observing consequents, which *are* certain, and working 'up' the syllogism, as it were, from consequent to ground.[22] Consider Kant's account of experimental procedure in the Blomberg lecture notes: 'I assume something and see whether something is sufficient for deriving therefrom a certain consequence or not' (*BL* 24:221). If our proposition were merely a generalization—'in general, *x*s have *P*'—then an instance of *x* that has *P* (or a counterfactual) would tell us nothing about the truth of the proposition. Kant's point is that only a proposition that determines a consequence through a ground can receive confirmation (or refutation) by an instance of the law (or a counterfactual).[23]

3.3. Knowledge and particular laws

To understand how a hypothesis can become a particular law, we need to place Kant's account of hypotheses within the register of 'assent' or 'holding for true' (*Fürwahrhalten*) outlined in the Canon of Pure Reason, where he considers the transition from opinion to knowledge. In contrast to cognition, understood in the strict sense of our awareness of the existence and distinctive features of objects, assent is an epistemic attitude we adopt toward a judgment that requires an awareness of the grounds we have for holding it to be true (Willaschek & Watkins, 2020, p. 3197). The strength of the epistemic attitude, Kant explains, is determined by the kinds of ground one can cite to justify one's assent (A822/B850). Subjective grounds typically refer to the state of the subject, such as a particular experience, the testimony one receives from someone else, or reason's need for systematic coherence. A subjective ground is 'sufficient' for assent if one finds it to be convincing for oneself. The 'touchstone' of a ground that is subjectively sufficient is the bets one would be willing to make on a judgment; a 'subjective conviction' or 'firm belief' is evident in the actions one is willing to take on the assumption that it is true (A824/B825). Objective grounds, in contrast, are based on the conditions that make a proposition true.[24] This includes reliable information about 'the constitution of the object', which indicates that the ground has objective probability of being true (A821/B849). Because the constitution of the object extends beyond the limits of possible experience, the sufficiency of an objective ground is not restricted to cognition. A sufficient objective ground for assent is one that is 'intersubjectively valid' and 'communicable': the 'touchstone' of objective sufficiency is 'the possibility of communicating it and finding it to be valid

[21] For a discussion of Kant's odd use of 'theory' in this passage, see Pasternack (2014, p. 68). C.f. *JL* 9:85, where Kant states that 'hypotheses always remain hypotheses, that is, presuppositions, whose complete certainty we can never attain.' Kant's point here, I take it, is that the probability of a hypothesis can only 'rise to an analogue of certainty'; for practical purposes, it can be held with conviction. See Section 3.3.

[22] Here I follow Stang's (2016, p. 213) claim that Kant's critical philosophy internalizes his pre-critical account of 'the grounding relation, and its relata, within experience itself.'

[23] To this extent Kant presages Goodman's (1983, p. 73) account of counterfactual conditionals, which demonstrates that 'Only a statement that is law-like—regardless of its truth or falsity or its scientific importance—is capable of receiving confirmation from an instance of it; accidental statements are not.'

[24] Kant is operating with a conventional definition of truth here, which 'rests upon agreement with the object' (A820/B848).

for the reason of every human being to take it to be true' (A820–821/B849). A judgment is objectively sufficient when it is based on grounds that one discovers are also grounds for other epistemic agents. Objectivity in the Doctrine of Method is thus not entirely coterminous with the 'objective validity' of the Transcendental Deduction, for it does not spontaneously follow the judgment. We have a sufficient objective ground to assent to a proposition if we *judge* that it has 'the same effect on the reason of others' (A820/B848).[25]

Kant identifies three epistemic attitudes that an act of judging can have, opinion (*Meinung*), belief (*Glaube*) and knowledge (*Wissen*) (A822/B850). Opinion is an attitude we take to a proposition when we judge that its ground is subjectively and objectively insufficient to gain our conviction. Belief is an attitude we take to a proposition when we judge that its ground is subjectively sufficient to merit our practical commitment, but objectively insufficient to gain the agreement of all others (A822/B850). Knowledge is marked by an attitude that naturally follows when we judge that the ground of a proposition is both subjectively and objectively sufficient, that is, 'valid for all human reason' (A820/B848). While our opinions and beliefs require ongoing assessment as our system of knowledge develops, opinions must be held more lightly, and wherever possible should not be used to ground further opinions (though this is often unavoidable; see A774–775/B802–803). The upshot of Kant's account of assent is that knowledge does not require that an object is given in intuition; it requires an objectively sufficient ground.

The hypothetical use of reason does not give rise to propositions that purport to be generally the case. Kant is clear that reason 'can cognize everything only *a priori* and necessarily, or not at all' (A775/B803). Even an opinion for Kant involves an epistemic attitude toward a proposition that 'can occur only as grounds of explanation of that which is actually given or as consequences in accordance with empirical laws of that which actually grounds what is actually given; they can occur only in the series of objects of experience.' Opinions are sufficient to guide action, for they carry *some* subjective and objective validity. For instance, physical hypotheses—a species of opinion—fit with one's system of particular laws (Empirical Possibility) and connect with what is actually given (Adequacy). To formulate a hypothesis makes it possible to test the rule against the consequents to see if they flow from it. Of course, no amount of experience can determine the truth of a hypothesis. As Kant explains in *Blomberg Logic*, 'With all hypotheses one must necessarily secure acceptance and certainty for them in such a way that they can be confirmed and derived not merely *a posteriori* through relation to their consequences, but also *a priori* through the *nexus*, that is, through relation to their grounds' (*BL* 24:221). We have sufficient justification to believe that a hypothesis correctly picks out the real ground when we judge (1) that it determines the consequences through a real ground and (2) that it can be derived *a priori* from its grounds within our best system of natural science. To move from opinion to knowledge requires that we judge that the objective validity of the hypothesis is *sufficient*, for instance, when we judge that an experimental proof will have the same effect on the reason of others.[26] To be conscious of the objective ground is to judge that the proposition to which we are assenting cannot be false, that is, that it is true. The ground, then, guarantees the truth of the belief, which thus amounts to knowledge.

Placing the hypothetical use of reason within the register of assent assists us to see how, contra Kreines (2009, p. 537), we can have 'justification for concluding that we have reached particular laws.' This justification comes in the form of objectively sufficient grounds, made available to us by reason's hypothetical use, which instructs us to reflect on conditioned appearances as consequents of a force, the causality of a substance (A648/B676). By directing the understanding to reflect on the consequent in search of a ground, the hypothetical use of reason guides our reflection on nature as something that contains the immediate necessity to which categorial determination gives rise. To ensure that hypothetical reasoning remains answerable to the empirical world, our reflection on a consequent as the exercise of a force must be disciplined to that which is given in intuition and to the other propositions we hold. Kant's account of hypotheses thus has a double effect. On the one hand, it enlivens us to the fact that we do not have sufficient objective grounds for many, if not most of the propositions in our best science. On the other hand, it demonstrates that particular laws are epistemically available to us.

4. Conclusion

In this paper I have argued that Kant's account of reason's hypothetical use assists us to see how the NA can address the problems associated with the various interpretations of Kant's account of particular laws. By maintaining that the natural modality of the law is grounded in actual entities, which carry genuine powers and dispositions, it explains how particular laws count as laws. Because assenting to a proposition is to judge that the natural modality of the law is grounded in actual entities, it also explains how such laws govern natural processes, not merely appearances. This accounts for the necessity of particular laws in a way that has purchase on nature: laws present the nature of actual entities to behave in a certain way. Natural science advances by an inductive procedure by which we formulate hypothetical propositions that adhere to Empirical Possibility and Actuality, guiding our observations and experiments as we seek to find out which properties are causally responsible for the consequents and which are not. When we judge that we have sufficient subjective grounds (e.g., the law coheres with other known laws) and sufficient objective grounds (e.g., it accounts for the consequents, and not others; it has the same effect on the reason of others), the hypothesis becomes a particular law. While we can call on the coherence of the law with other laws within the system of nature as grounds for our assent, natural modality is not grounded systematically. To assent to a proposition is to hold that the force of a substance necessitates a process or disposition in nature.

Kant's radical proposal is that our knowledge of natural processes cannot be justified by anything inaccessible to the human standpoint. The achievement of his critical philosophy is not simply to determine the boundaries of pure reason from within, but also to show how those boundaries can be used to discipline hypothetical reasoning to what can be objectively established without. To pose a question to nature is to assume a proposition that would, if it were true, entail its consequent, directing us to test the proposition against given consequents to see if it picks out the true ground. For a hypothetical proposition to receive confirmation from the instances that follow from it, its necessity cannot stem from the place it takes in a system. Necessity is already required for a proposition to stand as a hypothesis. A hypothesis lacks an objective foundation in the existential order precisely because its modal force extends beyond the existential to the metaphysical. The goal of experimental science is to *seek* the completion that is made available through our synthetic *a priori* knowledge of transcendental laws. Kant's *a priori* conception of science thus provides the framework for a research programme that can grow in reach and epistemic force and yet remains open to revision in many, if not most, of its domains.[27]

[25] This does not imply a form of doxastic voluntarism, in which we would have direct control over our assents. Kant's aim in the Doctrine of Method to show that we have control over the *maxims* that guide the acquisition of assents, meaning that we have indirect control over the assents we actually acquire. See Cohen (2014, pp. 318–320).

[26] Some commentators have argued that this opens a problem of degree: precisely how probable must a ground be to qualify as objectively sufficient? All I want to establish here is that Kant alters the empirical framing of probabilistic knowledge, for he demonstrates that *something* in the cognition must be certain for the hypothesis to get up and running in the first place. For a discussion of degrees of sufficiency, see Chignell (2007, pp. 326–328).

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