



Routledge Studies in Metaphysics

INDUCTIVE METAPHYSICS

INSIGHTS, CHALLENGES, AND PROSPECTS

Edited by

Andreas Hüttemann and Gerhard Schurz



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Gerhard Schurz**

First published 2026
by Routledge
605 Third Avenue, New York, NY 10158

and by Routledge
4 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

Routledge is an imprint of the Taylor & Francis Group, an informa business

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Funded by DFG (research unit FOR 2495, project number SCHU 1566/13-1) and Heinrich Heine Universität Düsseldorf (Open Access Fund).

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ISBN: 978-1-032-84674-3 (hbk)
ISBN: 978-1-032-84673-6 (pbk)
ISBN: 978-1-003-51440-4 (ebk)

DOI: 10.4324/9781003514404

Typeset in Sabon
by codeMantra

Access the Support Material: www.routledge.com/9781032846743

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4 Inductive Reasoning in Kant's Metaphysics of Nature

Kristina Engelhard¹ and Brigitte Falkenburg²

Abstract

It is well known that Kant used inductive arguments in his pre-critical philosophy, for example, in his 1764 Prize essay according to which metaphysics should follow Newton's "analytic method" of natural science. However, his critical metaphysics of nature also uses several inductive tools, contrary to the widespread belief that his apriorism is only compatible with deductive reasoning. In this chapter, we present three cases of inductive reasoning found in his critical metaphysics of nature. First, Kant carries out an "experiment of pure reason" in Preface B of the Critique of Pure Reason to rule out transcendental realism via the cosmological antinomy. Second, he argues in the Appendix to the Transcendental Dialectic that the transcendental ideas of traditional metaphysics can only serve as regulative principles for expanding our knowledge of nature, and he uses an inference to the best explanation (IBE) in the Metaphysical Foundations of Natural Science. Third, at the end of the Critique, he claims that these principles support doctrinal belief. The chapter shows how each of these cases of inductive reasoning can be understood as a kind of IBE and discusses the significance of Kant's arguments.

Keywords

- Inductive Metaphysics; Experiment of Reason; Theory of Matter; Doctrinal Belief

4.1 Introduction

It is well known that Kant used inductive arguments in his pre-critical philosophy. A famous example is the inductive reasoning in his *Universal Natural History and Theory of the Heavens* of 1755; there, he infers the large-scale structure of the universe from the shape of the solar system and the starry band of the Milky Way and generalizes Newton's mechanics to a theory of

DOI: 10.4324/9781003514404-5

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structure formation in the universe. In his Prize essay published in 1764, he claimed that metaphysics should follow Newton's "analytic method" of natural science, an inductive procedure of tracing back from phenomena to the principles governing them, which Newton called "deduction from the phenomena". What is less well known, however, is that Kant also uses some inductive tools in his critical metaphysics of nature, contrary to the widespread belief that his apriorism is only compatible with deductive reasoning. In the following, we present several quite different cases of inductive reasoning that can be found in the *Critique of Pure Reason (CPR)* and the *Metaphysical Foundations of Natural Science (MFNS)*. First, we analyze the "experiment of pure reason" in Preface B of the *Critique*, a thought experiment that Kant carries out to show that the cosmological antinomy rules out transcendental realism. We show that this thought experiment is still related to Kant's pre-critical account of the traditional analytic method and has inductive features (Section 2). Our further cases of inductive reasoning are related to the regulative use of reason in what Kant calls "immanent" or "transcendent" metaphysics, respectively. According to the appendix to the Transcendental Dialectic, the transcendental ideas of traditional metaphysics support regulative principles to expand our knowledge of nature and find a systematic unity underlying the variety of the phenomena and the empirical laws of nature, e.g. in terms of a fundamental power or force (Section 3). A closer look at the *Metaphysical Foundations* reveals that Kant in addition uses inductive criteria for theory choice in his defense of a dynamical theory of the constitution of matter (Section 4). At the end of the *Critique*, Kant claims that the regulative principles of pure reason, and in particular the idea of a systematic unity of nature that derives from the idea of God, support doctrinal belief (Section 5). Finally, we summarize how each of these cases of inductive reasoning can be understood as an inference to the best explanation (IBE) and discuss the significance of Kant's arguments (Section 6).

4.2 Kant's Argument in Favor of Transcendental Idealism

In Kant's research, the cosmological antinomy has been analyzed mainly in terms of its logical structure and the soundness of the proofs of thesis and antithesis, while its significance for Kant's critical philosophical project has been underestimated and neglected. Kant's main intention, however, was to demonstrate with the doctrine of the cosmological antinomy that transcendental realism is untenable because it gives rise to antinomy:

Accordingly, the antinomy of pure reason in its cosmological ideas is removed by showing that it is merely dialectical and a conflict due to an illusion [...] But one can, on the contrary, draw from this antinomy a true utility, not dogmatic but critical and doctrinal utility, namely that of thereby proving indirectly the transcendental ideality of appearances, if perhaps someone did not have enough in the direct proof in the Transcendental Aesthetic. The proof would consist in this dilemma. If

the world is a whole existing in itself, then it is either finite or infinite. Now the first as well as the second alternative is false (according to the proof offered above for the antithesis on the one side and the thesis on the other). Thus it is also false that the world (the sum total of all appearances) is a whole existing in itself. From which it follows that appearances in general are nothing outside our representations, which is just what we mean by their transcendental ideality.

(B 534–535) ³

In the Preface to the second edition of the *Critique* (B), Kant wanted to make this line of reasoning more popular by means of a thought experiment, the experiment of pure reason. The thought experiment belongs in the context of his famous remarks on the secure course of natural science. After emphasizing that “reason has insight only into what it itself produces according to its own design”, Kant argues that natural science only proceeds by combining principles “according to which alone the agreement among appearances can count as laws” and experiments that examine nature “like an appointed judge who compels witnesses to answer the questions he puts to them” (Kant 1787, B xiii). For Kant, this was the crucial revolution in the way of thinking that made natural science a science.

The “experiment of pure reason” draws on the analogy between the methods of natural science and the scientific metaphysics that Kant sought to establish. The “experiment of reason” is intended to show that Kant’s critical turn has a comparable result for metaphysics. Accordingly, for him, the crucial question is whether transcendental idealism can be confirmed, and transcendental realism refuted. In metaphysics, as cognition through reason from pure concepts, this question is posed to pure reason, as the metaphysical analog of natural phenomena investigated by experiment. So, only a thought experiment and no empirical experiment can be carried out here. This thought experiment is supposed to show that transcendental realism gives rise to contradictions and is therefore impossible, whereas the cognition of objects as appearances does not and is therefore possible (for details, cf. Falkenburg 2020, 216–223):

But herein lies just the experiment providing a checkup on the truth of the result of that first assessment of our rational cognition *a priori*, namely that such cognition reaches appearances only, leaving the thing in itself as something actual for itself but uncognized by us.

(B xix–xx)

The “checkup” (Gegenprobe) on truth is a consistency test for the urge of reason to find an unconditioned ground of a series of conditioned appearances:

For that which necessarily drives us to go beyond the boundaries of experience and all appearances is the *unconditioned*, which reason necessarily and with every right demands in things in themselves for

everything that is conditioned, thereby demanding the series of conditions as something completed.

(B xx)

This is the terminology of the Transcendental Dialectic, specifically the second kind of “dialectical” inferences of pure reason, i.e., the antithetic of pure reason, which concerns

the unconditioned unity of objective conditions in appearance [...] where reason [...] soon finds itself involved in such contradictions that it is compelled to relinquish its demands in regard to cosmology.

(B 433)

In Preface B, Kant does not explicitly mention the cosmological antinomy. But the passage quoted above clearly refers to it, continuing:

Now if we find that on the assumption that our cognition from experience conforms to the objects as things in themselves, the unconditioned *cannot be thought at all without contradiction*, but that on the contrary, if we assume that our representation of things as they are given to us does not conform to these things as they are in themselves but rather that these objects as appearances conform to our way of representing, then *the contradiction disappears*; and consequently that the unconditioned must not be present in things insofar as we are acquainted with them (insofar as they are given to us), but rather in things insofar as we are not acquainted with them, as things in themselves [...].

(B xx)

Kant hereby recalls the resolution of the cosmological antinomy, according to which the antinomy results from the assumptions of transcendental realism and can be resolved within the conceptual framework of transcendental idealism. If transcendental realism is understood as the metaphysical position according to which things in themselves can be known, and transcendental idealism as the opposing position according to which things in themselves cannot be known because our cognitive faculty is only capable of grasping appearances, then the refutation of transcendental realism by proof of inconsistency seems to provide a compelling argument in favor of transcendental idealism. In any case, this is what Kant seeks to demonstrate with his experiment of pure reason. He thought to have provided an independent proof of transcendental idealism that did not rely on the Transcendental Analytic, and in view of the lack of comprehension met with by the first edition of the *Critique* he wanted to explain this point in popular terms.

So far, so good. But to what extent is this an inductive argument? Kant's thought experiment is deductive. In the doctrine of antinomies, he derives contradictions from the premises of transcendental realism and presents transcendental idealism as a way out. The way Kant presents his line of

reasoning is not an inductive IBE, but a deductive inference to transcendental idealism as the *only* explanation.

Here, two answers must be given. The first, and obvious, is that it is debatable whether Kant's transcendental idealism is the only possible alternative to the kind of transcendental realism he argued against.⁴ The second, less obvious answer is that Kant himself seems to have seen a need for further support, for he underpins his thought experiment with an explicit reference to the traditional analytic-synthetic method, i.e., a two-stage method with analysis as the inductive step and synthesis as a subsequent deductive step (Beaney and Raysmith 2024; Engfer 1982). The method traces back to ancient geometry, to Pappus's commentary on Euclid. It was widespread in early modern science and philosophy. Its analytic step aimed at inferring the underlying principles from certain given problems or phenomena, and the subsequent synthetic step aimed at deriving the explaining the problem or phenomena from the principles. The most prominent versions of it were Galileo's resolute-compositive method; Descartes's Rules 2 and 3 of the *Discours* (Descartes 1637, 92); and Newton's method of analysis and synthesis, as explained in *Query* 31 of the *Opticks* (Newton 1730, 404), which applied Pappus's mathematical method to physics. Kant adopted the method, or different variants of it, in his pre-critical writings and transformed it within his critical philosophy (cf. Falkenburg 2020, Chapters 2 and 6). In contrast to the prevailing 18th-century philosophy, and following Newton, he repeatedly emphasized, both in the 1764 Prize essay and in the passage considered here, that it was a two-stage procedure in which analysis must be complemented by synthesis.

The point of interest in this context is an indirect reference to Pappus at the end of Kant's thought experiment, and a corresponding footnote. Kant concludes the above-quoted passage on the experiment of pure reason with the following remark: "then this would show that what we initially assumed only as an experiment is well grounded" (B xx-xxi).

If we may assume that he was familiar with the widely used Latin version of Pappus's commentary on Euclid, the whole passage suggests that Kant has *both* steps of the analytic-synthetic method in mind here and is thinking of "problematic" analysis in the sense of Pappus, which is in fact completed by a check of whether the result of the analysis is "possible" or "impossible", i.e., a consistency test:

There are two kinds of analysis: one seeks after truth, and is called 'theorematic'; while the other tries to find what was demanded, and is called 'problematic'. [...] In the case of the problematic kind, we assume the proposition as something we know, then proceeding through its consequences, as if true, to something established, if the established thing is possible and obtainable, which is what mathematicians call 'given', the required thing will also be possible, and again the proof will be the reverse of the analysis; but should we meet with something established to be impossible, then the problem too will be impossible.

(Pappus 1589, 83–84)

In the corresponding footnote, Kant reinterprets the division of the *Critique* into two parts, Transcendental Analytic, and Transcendental Dialectic, in terms of the analytic-synthetic method. Here he again draws on the analogy between metaphysics and natural science, this time in a comparison with chemistry. The comparison is intended to show that the crucial aspect of transcendental idealism that makes the contradictions of transcendental realism disappear is the distinction between phenomena and noumena, or appearances and things in themselves:

* This experiment of pure reason has much in common with what the *chemists* sometimes call the experiment of *reduction*, or more generally the *synthetic procedure*. The analysis of the metaphysician separated pure *a priori* knowledge into two very heterogeneous elements, namely those of the things as appearances and the things in themselves. The *dialectic* once again combines them, in *unison* with the necessary rational idea of the *unconditioned*, and finds that the unison will never come about except through that distinction, which is therefore the true one (B xxi).

As a footnote to a thought experiment that comes across as deductive, this reference to the analytic-synthetic method of Pappus and his successors in early modern science is puzzling. In any case, it shows that Kant still resorts to inductive reasoning to some extent in the *Critique of Pure Reason*, if only to make transcendental idealism more popular by pushing the analogy with natural science further and further. Let us now consider two different cases of inductive reasoning which play a major role and indeed have systematic significance for Kant's critical philosophy. They concern the results of the *Critique* regarding Kant's distinction between "immanent" and "transcendent" metaphysics of nature (B 873), i.e., the effects of the regulative principles of pure reason on rational physics and natural theology.

4.3 The Regulative Use of Reason

In the Appendix to the Transcendental Dialectic, Kant explains the regulative use of the ideas of pure reason – the metaphysical ideas of the soul, the world, and God. According to the Transcendental Dialectic, they give rise to transcendental illusion and fallacious conclusions. According to Kant, the ideas of the soul and God do not give rise to contradiction, whereas the idea of the world results in the cosmological antinomy underlying the "experiment of reason" discussed above. The Appendix on the regulative ideas of pure reason starts with distinguishing between an "immanent" and a "transcendent" use of these ideas (B 671). Kant then explains the "immanent" use of the transcendental ideas in terms of regulative principles which serve to expand our knowledge of nature.⁵ The

general principle underlying them is the principle of the systematic unity of knowledge, which

presupposes an idea, namely that of the form of a whole of cognition, which precedes the determinate cognition of the parts and contains the conditions for determining a priori the place of each part and its relation to the others.

(B 673)

This principle and all principles deriving from it are *inductive*. In the *Critique of the Power of Judgement* (Kant 1790), Kant transforms it into the regulative principle of the purposiveness of nature. There, the latter principle serves as an inductive principle that helps to establish systematic unity under the empirical laws of nature on the one hand and to explain the structure of organisms and the systematic organization of the chain of natural beings in terms of teleological explanations without objectivity, on the other hand.

In the first Critique, Kant distinguishes the three regulative principles of *homogeneity*, *specification*, and *continuity*. They support inductive inferences from a manifold of phenomena to general principles that establish systematic unity between them, such as the idea of a *fundamental power* (B 677). Kant emphasizes that these principles are not constitutive of the systematic unity of nature but regulative guidelines of natural science. As logical principles, they constitute the systematic unity of our *cognition* of nature, giving rise to methodological principles of natural science. According to Kant, their use in natural science presupposes the transcendental claim that nature indeed has systematic unity, which is however not objective but only subjective.⁶

So far, the function and scope of the regulative principles are uncontroversial in Kant's research, and it is usually assumed that they mainly concern natural science beyond what Kant calls "proper science" at the beginning of the *Metaphysical Foundations*, i.e., the "historical doctrine of nature" and/or "improper science" (4:468). Kant himself, however, also needs the regulative principles for his metaphysics of nature, as depicted in the Architectonic Chapter of the *Critique* (B 873–876). In Kant's "immanent" metaphysics of nature, i.e., in the *Metaphysical Foundations*, they come into play e.g. via the idea of absolute space as an ideal inertial system (4:480–482) or via the idea of fundamental forces (4:502–525). But the regulative principles are also crucial for Kant's views about "transcendent" metaphysics, i.e., for his account of doctrinal belief.

4.4 Inference to the Best Explanation and Theory Choice in Rational Physics

In the Dynamics chapter of his *Metaphysical Foundations of Natural Science*, Kant develops a dynamical theory of matter that grounds all essential

properties of matter on two fundamental forces, attractive and repulsive force, and thereby is supposed to render an explanation of the “possibility of matter in general” (MFNS 4:521), more precisely an explanation of how it is possible that matter fills space – amongst other things to be explained.⁷ Kant claims in Proposition 1: “Matter fills a space, not through its mere *existence*, but through a *particular moving force*.” (MFNS 4:497)

And in Proposition 2 he specifies:

“Matter fills its space through the repulsive forces of all of its parts, that is, through an expansive force of its own, having a determinate degree, such that smaller or larger degrees can be thought to infinity.”
(MFNS, 4:499)

This claim is supplemented in Proposition 5 by attractive force: “The possibility of matter requires an *attractive force* as the second essential fundamental force of matter.” (MFNS 4:508)

This theory relates to the second antinomy and its resolution by transcendental idealism in the first *Critique* insofar as it appears at the first glance to make the same claim as the antithesis that Kant refutes, namely that “matter is divisible to infinity” (Proposition 4 of the Dynamics, MFNS 4:503). A closer analysis of the text however shows that this is not the case, but rather, that Kant in the *Metaphysical Foundations* makes use of the ideas of reason as guided by the principles of the regulative use of reason.⁸ It is even possible to assume that his theory of matter includes some form of monadism or atomism insofar as he also claims in Proposition 2 of the Mechanics chapter that the number of substances in the universe cannot be increased or diminished.⁹

Kant provides proofs for each of his propositions. For example, for proposition 5 of the Dynamics, he argues with the so-called balancing argument which says that there has to be an attractive force to counterbalance repulsive force because otherwise matter’s density would diminish to infinity. Only if there is some balance between repulsive and attractive forces constituting matter’s density, matter’s density can have a value greater than infinitely small, which it in fact has in many regions of space (Warren 2010). The proofs in the *MFNS* are still controversial in the Kant scholarship as to how they actually work and whether Kant’s laws are mainly derived from the transcendental principles in the first *Critique* (Friedman 2014, 533–537),¹⁰ or rather are independent transcendental arguments (Watkins 2019, Chap. 4). Regardless of these issues, in a section at the very end of the Dynamics chapter entitled *General Remark to Dynamics*, Kant additionally argues in favor of his dynamical theory, which he then calls the “metaphysical dynamical mode of explanation” (MD explanation henceforth), by comparing this theory in great detail with a competing theory he

calls the “mathematical-mechanical mode of explanation” (MM explanation henceforth) (MFNS 4:523–535). This rival theory is atomism, which is essentially characterized by two theses, namely the claim that there are atoms that are absolutely dense, extended, impenetrable, and indivisible bodies, and the claim that there is empty space. The comparison is in terms of their theoretical and explanatory advantages and disadvantages. Therefore we argue that in the *General Remark to Dynamics* Kant is actually performing an IBE in order to argue for the truth of his dynamical theory of matter.

It may be an issue which status this comparison of theories has: Is it merely an additional section that highlights Kant's own dynamic theory of matter against atomism, or is it actually the only external proof of the truth of his theory, while his proofs given to each proposition are only internal proofs within transcendental idealism? Regardless of this question, what matters is that and how Kant uses this method – probably intuitively.¹¹

There are several points that can be taken as evidence for the claim that Kant in fact performs an IBE: First, Kant terms the two theories, his own dynamical theory of matter and atomism as “modes of explanation”. Hence, we can take it that Kant believed that his theory of the fundamental forces, attractive and repulsive force, serves first of all, as an explanation of the phenomenological property of matter's density. In Remark 2 at the end of the constructive part of the Dynamics chapter, he even grants: “I am well aware of the difficulty in this mode of explaining the possibility of a matter in general.” (MFNS 4:521). Second: Alongside his dynamical theory of matter, atomism also figures as an explanation. Kant overtly highlights the theoretical and explanatory advantages and disadvantages of both theories and draws a conclusion from the score. On this basis, he argues that overall, his dynamical theory wins the competition because it has more advantages and fewer disadvantages than the rival MM explanation. Third: Nevertheless, Kant overtly points out that the MM mode of explanation has a number of advantages over his own dynamical theory.

Each of these types of evidence will now be discussed to support the thesis of this part of the chapter.

Ad (1): What is to be explained in the Dynamics chapter by both theories is first the density of matter. MD-theory explains the density of matter by thinking of the specific fundamental constitutive powers of matter, attraction and repulsion, that they are always co-present in a certain ratio. This ratio can have different values to the effect that density can in principle have every possible value from infinitely small to infinitely large. MM-theory explains the density of matter by assuming that a piece of matter ultimately consists of a certain number of atoms in empty space. The density of a piece of matter is covariant with the number of atoms in a given volume of space. It remains to be explained, as Kant points out, how

it is possible that there can be a “*specific variety of matters*”, as he puts it, probably meaning different kinds of matter:

But now as to the procedure of natural science with respect to the most important of all its tasks – namely, that of explaining a potentially infinite *specific variety of matters* – one can take only two paths in this connection: the *mechanical*, by combination of the absolutely full with the absolutely empty, and an opposing *dynamical* path, by mere variety in combining the original forces of repulsion and attraction to explain all differences of matters.

(MFNS 4:532)

Kant does neither explain here why he thinks that this is the most important task of science nor why he believes that only these two explanations are possible. Concerning the first point, the context two pages later makes it clear that he refers to another of his claims, namely that science’s ultimate aim is to develop reductive explanations, more precisely, reductive causal grounding explanations.¹² As mentioned in Section 3, reductive causal grounding explanations follow the regulative idea of systematicity that gives rise to the idea of fundamental powers. Science’s main goal is hence to reduce empirical phenomena to the smallest number of powers as Kant stresses in the *Metaphysical Foundations*:

[...] all natural philosophy consists, rather, in the reduction of given, apparently different forces to a smaller number of forces and powers that explain the actions of the former, although this reduction proceeds only up to fundamental forces, beyond which our reason cannot go.

(MFNS 4:534)

This assumption is understandable if Kant is supposed to hold a causal powers theory. Given that only the fundamental powers are causally efficacious it is clear why arriving at these powers is important: Only if the fundamental powers are known, the laws describing the behaviors they give rise to make it possible to have complete knowledge of the phenomena. This is very roughly what systematicity is about. Although Kant believes that atomism fails in providing such a reductive causal grounding explanation, he is well aware that atomism provides an explanation for the different kinds of matter. And Kant even grants that MM explanation has an advantage over MD explanation in doing so.¹³ He admits that the advantage is of a high value, it is the simplicity of principles. As mentioned in Section 3 of this chapter, homogeneity is one of the three regulative principles of pure reason according to which experience has to be organized to

render them scientific, i.e., as a part of a system of knowledge. It is for this reason that Kant prefers his dynamic theory of matter: because this theory relies solely on powers and their laws of action and because it is homogeneous and simple insofar as it explains phenomena by powers and reduces powers to fundamental powers. Kant draws a link between the principle of homogeneity and Ockham's razor in the dialectic of the first *Critique* (CPR B 686). In this sense the MD theory is simpler than the MM theory since on the fundamental level of nature the only kind of entity that is postulated in MD theory are powers and the substances that instantiate them, while MM theory postulates atoms of different kinds and empty space.

Ad (2): Kant's reasoning and his associated terminology in the *General Remark to Dynamics* is a telling case of an IBE, and it is also remarkable because an extensive evaluative comparison of this kind can - according to our knowledge - not be found elsewhere in his work: one theory has an "advantage" over the other (MFNS 4:524; 524; 525; 525), a disadvantage is "on account" of one of the theories (MFNS 4:531), a theory has a "gain" over the other (MFNS 4:532), one theory is "the most tractable to mathematics" rather than the other (MFNS 4:533), a theory has an "authentication" rather than the other (MFNS 4:533), one theory is "much more appropriate and conducive to experimental philosophy" than the other (MFNS 4:533), one theory is the "antagonist of a hypothesis" of the other (MFNS 4:534). This terminology strongly supports the diagnosis that Kant is in fact undertaking a cost-benefit analysis of the two antagonist theories in terms of their theoretical virtues.

We can only very briefly summarize which further points of comparison are included in Kant's evaluation, besides the ones already mentioned. An important point is the easiness with which the theory allows for the mathematization. In Kant's eyes, this is an important criterion because he also claims that the scientific status of a discipline depends on the extent to which it can be mathematized (MFNS 4:470).¹⁴ Another point of comparison is whether the theory allows for an explanation of impenetrability or not. Interestingly, Kant sees clearly that the fundamental forces cannot be explained simply by their fundamental status (MFNS 4:524f.). Still, another point of comparison consists in whether the theory allows for homogeneous explanations, i.e., whether moving forces can be explained by other kinds of forces. A further group of points of comparison is whether the theory makes it possible to explain empirical phenomena and empirical laws, such as the aggregation states of matter, the laws of hydrodynamics (Bernoulli equation), the phenomena of elasticity, and the phenomena of chemical interaction. Here it is unclear which theory does better and Kant only emphasizes that MD-explanation is able to explain these phenomena. The most important drawback of the MM theory in Kant's eyes is that it

assumes empty space. Kant's argument is that empty space is not perceivable and hence there can never be empirical evidence whether there is empty space or not.¹⁵ On the other hand, he grants that there can be no insight into the possibility and reality of fundamental forces.¹⁶ A final important advantage of the MD-theory according to Kant is that it fits better the transcendental principles, in particular, because it does not postulate empty space that Kant deems highly problematic because it is an empty concept.

Importantly, Kant believes that MD- and MM explanations are the only possible explanations (MFNS 4:532; citation above). This puts him in a position to be convinced that a trade-off between the two theories leads to strong certainty. The only sources of uncertainty in this trade-off may lie (a) in the possibility of a different evaluation of the advantages and disadvantages of the theories, e.g. in light of different aims of science, or (b) in new empirical evidence about properties of matter that the theories have to explain adequately.

Ad (3): It should have become clear by now that Kant really believes that there are advantages of the rival MM theory over his favored dynamism. Even if it has disadvantages this does not rule it out as a candidate for explaining the supreme phenomenon of nature, the different kinds of matter, and matter's density.

The discussion so far has shown that Kant in fact performs an IBE in his rational physics when arguing for his favored dynamic theory of matter. How this can be reconciled with his claim that rational physics has to be an a priori discipline of apodictic certainty is shown elsewhere (Engelhard, under review).

4.5 How the Regulative Principles Support Doctrinal Belief

Let us now turn to Kant's account of the "transcendent" use of the regulative principles, which is closely related to the goal of "the cognition of a highest being [...], for which our understanding is not equipped at all" (B 664). In the chapter *On the final aim of the natural dialectic of human reason*, the second chapter of the Appendix to the Transcendental Dialectic, Kant repeatedly emphasizes that there is no such cognition. Nevertheless, the regulative principles, in their "transcendent" use, pave the way to a doctrinal belief, which, though not objectively, is at least subjectively justified and supported by firm confidence:

[...] so that I would say too little if I called my taking it to be true merely having an opinion, but rather even in this theoretical relation it can be said that I firmly believe in God; but in this case this belief [...] must be called a doctrinal belief, which the theology of nature (physico

theology) must everywhere necessarily produce. In regard to this same wisdom, in respect of the magnificent equipment of human nature and the shortness of life [...], there is likewise to be found sufficient ground for a doctrinal belief in the future life of the human soul. [-] The expression of belief is in such cases an expression of modesty from an objective point of view, but at the same time of the firmness of confidence in a subjective one.

(B 854–855)

Kant roughly argues as follows. According to the theological idea of God, the world of appearances must be considered *as if* all possible experiences had an absolute unity. On the one hand, this unity is the systematic unity of all empirical phenomena depending on each other according to the laws of nature, assumed in accordance with the regulative principles of homogeneity, specification, and continuity (B 673–690). On the other hand, it is assumed that this systematic unity can be traced back to a supreme intelligence (B 700–701) and understood in terms of purposiveness, pointing to the idea of the intention of a creator of the order in the world:

This highest formal unity that alone rests on concepts of reason is the purposive unity of things; and the speculative interest of reason makes it necessary to regard every ordinance in the world as if it had sprouted from the intention of a highest reason.

(B 714)

In this way, the transcendental idea of God as the cause of a systematic purposeful unity of appearances is based on an analogy to our reason. In its “immanent” use, this transcendental idea gives rise to the empirical investigation of nature based on the principle of the systematic unity of knowledge, specified according to the regulative principles of homogeneity, specification, and continuity. In its “transcendent” use, however, this idea supports the physico-theological proof of the existence of God. For Kant, this proof is just as deceptive as the other traditional proofs of the existence of God, i.e., the cosmological and ontological proofs, on which, according to him, the physical-theological proof ultimately depends (B 655–658). Yet this proof of the existence of God retains an extraordinary significance for him:

This proof always deserves to be named with respect. It is the oldest, clearest and the most appropriate to common human reason. It enlivens the study of nature, just as it gets its existence from this study and through it receives ever renewed force. It brings in ends and aims where

they would not have been discovered by our observation itself, and extends our information about nature through the guiding thread of a particular unity whose principle *a* is outside nature. But this acquaintance also reacts upon its cause, namely the idea that occasioned it, and increases the belief in a highest author to the point where it becomes an irresistible conviction.

(B 624–625)

The significance of the physico-theological proof is only subjective. According to the proof, we must assume the existence of a supreme being as the cause of the systematic unity of nature. However, the necessity of this assumption is a demand of reason, but neither a logical necessity nor a transcendental condition of natural science (B 725–727). The transcendental idea of God supported by the proof is useful rather than harmful for reason (B 715) because it gives rise to the regulative principles that serve as guidelines for the investigation of nature. But according to the *Critique*, no objective knowledge of God as the cause of the unity of nature is possible. Kant emphasizes that we can only conceive this cause as “a substratum, unknown to us, of the systematic unity, order, and purposiveness of the world’s arrangement”, although “certain anthropomorphisms” are also admitted (B 725).

In addition, Kant claims that “the thesis of the existence of God belongs to doctrinal belief” because “I know no other condition for this unity that could serve me as a clue for the investigation of nature except insofar as I presuppose that a highest intelligence has arranged everything in accordance with the wisest ends.” (B 854)

The structure of the entire argument is roughly as follows:

- 1 Premise: Reason demands for the systematic unity of knowledge.
- 2 Consequence: Our knowledge of nature aims at systematicity.
- 3 Inductive inference: The empirical appearances in nature show systematic unity.
- 4 Premise: Reason demands a cause for the systematic unity of nature.
- 5 Inductive inference: The idea of God explains this systematic unity.
- 6 Corollary: This explanation supports doctrinal belief in God.
- 7 Premise: God is not an object of possible experience.
- 8 Consequence: We do not have objective knowledge of God.
- 9 Conclusion: Therefore, this doctrinal belief is merely subjective.

The deduction of (2) from premise (1) is followed by an inductive step that infers the claim (3) about the systematic unity of nature by applying (2) to our knowledge of nature. The next premise, (4), is obviously based on a

“transcendent” use of the principle of causality. Then, in (5), the idea of God is introduced in an IBE – which is perhaps the *only* explanation, if any explanation may be given at all, and if the cause of the systematic unity of nature is just understood in terms of “a substratum, unknown to us” (B 725). Corollary (6) then makes use of the physico-theological proof for the existence of God, as can be seen from the passage quoted at the beginning of this section (“[...] must be called a doctrinal belief, which the theology of nature (physico-theology) must everywhere necessarily produce”, B 854–855). Premise (7) and its consequence (8) are based on the results of the Transcendental Analytic and Transcendental Dialectic. They imply the conclusion (9), as this belief is not based on objective knowledge.

For Kant, doctrinal belief is a kind of “pragmatic belief” resulting in “merely theoretical judgments” that are “an *analogue* of practical judgments” (B 853). This doctrinal belief is thus stronger than holding merely opinions, but certainly weaker than objective knowledge on the one hand and practical judgments on the other. However, the object of doctrinal belief, the idea of God, is related to the “ideal of the highest good” (B 832), the world as a system of purposes (B 838–844), and the “essential ends of humanity” (B 878) (for more details, cf. Chignell 2007 and my discussion in Falkenburg 2020, 233–238). Thus, it has an important systematic function for Kant in the transition from theoretical to practical philosophy, i.e., from his *Metaphysics of Nature* to the *Metaphysics of Morals*.

4.6 Summary and Conclusions

We have presented four examples of inductive reasoning in Kant's theory of nature. Each of them can be understood in terms of an IBE. One of them is well known, i.e., the regulative principles, which derive from the ideas of pure reason and serve as guidelines for the expansion of our empirical knowledge of nature. However, the other three examples show that Kant's natural metaphysics is in some respects less *a priori* than often assumed.

Our first example was the “experiment of pure reason” in Preface B of the first Critique. In a thought experiment, Kant argues that under the preconditions of transcendental realism, reason's quest for the unconditional leads to contradictions (i.e., to the cosmological antinomy) which only transcendental idealism can avoid. This thought experiment, however, is deductive rather than inductive, insofar as Kant concludes that transcendental idealism is the only option allowing for a consistent metaphysical position. From today's point of view, Kant's argument is not convincing for two reasons: first, its validity depends on Kant's proofs in the mathematical antinomy, which are based on 18th-century metaphysics and, independently of transcendental idealism, can no longer be considered tenable

today; second, transcendental idealism is not the only alternative to the version of transcendental realism assumed by Kant in his proofs. Although Kant himself did not expect such a refutation, however, he saw the need to support his argument by means of an analogy to the inductive methods of empirical science.

The second example is well known and largely uncontroversial in Kant's research, but we had to mention it for the sake of completeness. In the Appendix to the Transcendental Dialectic, Kant argues that the transcendental ideas of traditional metaphysics can only serve as regulative principles for expanding our knowledge, and he distinguishes between their "immanent" and their "transcendent" use. A general principle underlying them is the principle of the systematic unity of knowledge, which is indispensable for empirical science and which he further explores in his third Critique. The "immanent" use of the regulative principles in Kant's metaphysics of nature concerns indispensable principles of rational physics such as the ideas of absolute space or of fundamental forces. The "transcendent" use concerns reason's quest for the unconditional and transcends the limits of possible knowledge. Also from today's perspective, it is undeniable that the unity of knowledge is an indispensable methodological principle of any science, and that it is a guiding line for many good, if not best, explanations in the empirical sciences.

As a third example, we showed how Kant in the *Metaphysical Foundations*, in the General Remark on Dynamics, complemented his a priori proofs for a dynamical theory of matter by additional arguments. These arguments and their systematic status are rather controversial in Kant's research. We demonstrated that they provide criteria for the choice between two rival theories of matter, i.e., mechanical atomism and a dynamical continuum theory, respectively. We argued that these arguments are inductive and reconstructed them as inferences to the dynamical theory as the explanation considered the best one by Kant. Clarifying the systematic status of these arguments in Kant's theory of matter was beyond the scope of the present chapter; what we wanted to show is that they are unexpected inductive elements in his metaphysics of nature.

Finally, we looked at Kant's arguments in favor of doctrinal belief, a neglected part of his critical philosophy. In their "transcendent" use, the regulative principles support a doctrinal belief, which, though not objectively, is at least subjectively justified. For Kant, this doctrinal belief is backed by firm confidence, and it is more than mere opinion. Our reconstruction shows how Kant's line of reasoning leads from reason's principle of the systematic unity of knowledge to the physico-theological explanation of the systematic unity of nature by God. The last step is clearly an inference to God as the best explanation of the systematic unity of nature.

This explanation is not objectively valid, but according to Kant subjectively convincing, and even from today's perspective, this conviction cannot be denied to him.

Funding and Acknowledgments

This work was supported by the DFG (Deutsche Forschungsgemeinschaft), research unit FOR 2495, FA 261/15-1 and FA 261/15-2. We would like to thank an anonymous referee for helpful comments on an earlier version of the chapter.

Notes

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- 3 Our interpretation of Kant's work is based on the original language of the text as published in the Akademie Ausgabe Kant (1900-). All citations are based on the Cambridge edition.
- 4 To refute a theory by contradiction does not imply that a given non-contradictory alternative is true. There were unconceived alternatives of transcendental realism, which are contrary but not contradictory to transcendental idealism (Willaschek 2018, 245–249). After all, transcendental idealism is sufficient, but not necessary for avoiding the antinomy (cf. Falkenburg 2020, 219) – not to speak of the invalidity of Kant's proofs of the antinomy in view of 20th century physics (cf. Wind 1934 and Falkenburg 2021).
- 5 Cf. Banham 2013, Breitenbach 2021, Proops 2021, Chap. 17, and Watkins 2019, Chap. 10.
- 6 Cf. B 678–686 and Willaschek 2018, 237–238.
- 7 For general outlines of the account cf. Warren 2001a,b.
- 8 For details cf. Engelhard 2005, 414–427.
- 9 “[...] the quantity of matter, with respect to its substance, is nothing else but the aggregate of substances of which it consists. Therefore, the quantity of matter cannot be increased or diminished except in such a way that new substance thereof arises or perishes. Now substance never arises or perishes in any change of matter; so the quantity of matter is also neither increased nor diminished thereby, but remains always the same, and, indeed, as a whole – in such a way, that is, that somewhere in the world it persist in the same quantity, although

- this or that matter can be increased or diminished, through addition or separation of parts.” (MFNS 4: 542). The modelling account of the transcendental ideas makes it possible to avoid an open contradiction between the two claims: cf. Engelhard 2023. How this account relates to Kant’s empirical realism is a deeper question that is beyond the scope of this paper; for some recent interpretations of Kant’s realism cf. Allais 2015, Rosefeldt 2022.
- 10 Strangely, Friedman acknowledges in his commentary to the MFNS that Kant’s dynamic theory of matter might only be inductively supported (Friedman 2013, 569).
 - 11 Engelhard (under review) argues for the stronger thesis that it makes sense to believe that this IBE is part of an overall methodology of critical metaphysics in Kant. In contrast to the use of IBE in theories that endorse scientific realism today, Kant’s use of method cannot be substantiated by a comprehensive methodological investigation such as in Lipton 2004. Kant understands probability in the epistemic sense; hence, he could have assumed that by increasing the probability of the truth of a hypothesis *b*, an IBE increases the justification of our belief in *b*. In many other cases Kant rather makes use of a form of IBE that may be described as a specific kind of inference to the only possible explanation, which is one way to align transcendental arguments with contemporary methodology. Similar to Kant, contemporary scientific realists also use IBEs to argue for non-empirical, meta-theoretical hypotheses, such as the thesis of realism itself (Schurz 2009).
 - 12 Most important textual evidence for the connection between reduction, reductive explanations, and powers in Kant is prominently CPR B 676f. For reduction in Kant in this section of the MFNS cf. McNulty 2022, 182–196; for his account of scientific power reduction cf. Howard 2021 and Engelhard (under review).
 - 13 “For to be authorized in erecting an hypothesis, it is unavoidably required that the *possibility* of what we suppose be completely *certain*, but with fundamental forces their possibility can never be comprehended. And here the mathematical-mechanical mode of explanation has an advantage over the metaphysical-dynamical [mode], which cannot be wrested from it, namely, that of generating from a thoroughly homogeneous material a great specific variety of matters, which vary both in density and (if foreign forces are added) mode of action, through the varying shape of the parts and the empty interstices interspersed among them.” (MFNS 4: 524f.).
 - 14 However, Friedman is convinced that this is only a hasty evaluation by Kant at this point (Friedman 2013, 116; 237f.). Overall MD-theory is more appropriate to construct physical phenomena in pure intuition.
 - 15 Also Westphal stresses that in the analogies of experience in the first Critique Kant admits that empty space “is a logical, ontological, and even a physical possibility” (Westphal 2004, 81).
 - 16 MFNS 4: 524. Earlier Kant already conceded that “Attraction, on the other hand, can give us in itself either no sensation at all, or at least no determinate object of sensation, and it is therefore so difficult for us to understand as a fundamental force.” (MFNS 4: 510; 513).

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