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Laws of Nature and Causal Necessity

Abstract: This paper consider the necessity of causal laws of nature in relation to Kant's works explicitly addressed to natural science (such as the *Prolegomena* and the *Metaphysical Foundations of Natural Science*), and also to the second edition of the *Transcendental Deduction* and the *Critique of the Power of Judgement*.

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In this essay I consider Kant's conception of the causal necessity expressed by particular empirical laws of nature from three different yet related points of view. In the first section I consider Kant's clearest and most explicit treatments of such necessity in the *Prolegomena to Any Future Metaphysics* (1783) and *Metaphysical Foundations of Natural Science* (1786). In the second I consider Kant's much more abstract treatment in the *Transcendental Deduction of the Categories* in the second edition of the *Critique of Pure Reason* (1787). Both of these sections focus on the role of the faculty of understanding. In the third section, however, I turn to the essential and indispensable role of the faculty of reflective judgement discussed in the *Critique of the Power of Judgement* (1790).

1 The *Prolegomena* and *Metaphysical Foundations*

Kant presents his official "answer to Hume" in § 29 of the *Prolegomena*. He begins with cases of Humean constant conjunction, which he illustrates by the proposition that if a body is illuminated long enough by the sun then it becomes warm. Such a proposition, however, is a merely subjective judgement of perception, and, if it is to become an objective judgement of experience, it must be regarded as universally valid and necessary. The resulting "proposition of experience" is that the sun is through its light the cause of the warmth: "The foregoing empirical rule is now regarded as a law, and indeed as valid not merely of appearances, but of them on behalf of a possible experience, which requires universally and thus

necessarily valid rules”.¹ Kant’s point, then, is that when we apply the concept of cause to a Humean constant conjunction, we transform a merely subjective connection of perceptions into a truly universal and necessarily valid causal law of nature.

Kant’s discussion of this example begins considerably earlier in the *Prolegomena* (§ 20), in the course of his initial introduction of the distinction between judgements of perception and judgements of experience:

To have a more easily understood example, consider the following: If the sun shines on the stone it becomes warm. This judgement is a mere judgement of perception and contains no necessity, however often I and others also have perceived this; the perceptions are only usually found so combined. But if I say: the sun *warms* the stone, then beyond the perception is added the understanding’s concept of cause, which connects *necessarily* the concept of sunshine with that of heat, and the synthetic judgement becomes necessarily universally valid, hence objective, and changes from a perception into experience.²

This distinction between two kinds of judgements, one subjective and the other objective, has appeared to many commentators to be problematic and, accordingly, to be dropped in the second edition of the *Critique* in favor of the view that all judgements, as such, must be objective. Nevertheless, the formulation of the general principle of the (three) Analogies of Experience employed in the second edition (together with the following additional paragraph labeled “Proof”) emphasizes a parallel (but less controversial) distinction between perception and experience: “*Experience is possible only through the representation of a necessary connection of perceptions.*”³

But what is most problematic in Kant’s answer to Hume is the suggestion that all experience, even that which is in itself entirely a posteriori and contingent, must nevertheless involve some kind of necessary connection. What does it

1 “Die obige empirische Regel wird nunmehr als Gesetz angesehen und zwar nicht als geltend bloß von Erscheinungen, sondern von ihnen zum Behuf einer möglichen Erfahrung, welche durchgängig und also nothwendig gültige Regeln bedarf.” *Prolegomena*, AA 04: 312.

2 “Um ein leichter einzusehendes Beispiel zu haben, nehme man folgendes: wenn die Sonne den Stein bescheint, so wird er warm. Dieses Urtheil ist ein bloßes Wahrnehmungsurtheil und enthält keine Nothwendigkeit, ich mag dieses noch so oft und andere auch noch so oft wahrgenommen haben; die Wahrnehmungen finden sich nur gewöhnlich so verbunden. Sage ich aber: die Sonne erwärmt den Stein, so kommt über die Wahrnehmung noch der Verstandesbegriff der Ursache hinzu, der mit dem Begriff des Sonnenscheins den der Wärme nothwendig verknüpft, und das synthetische Urtheil wird nothwendig allgemeingültig, folglich objectiv, und aus einer Wahrnehmung in Erfahrung verwandelt.” *Prolegomena*, AA 04: 301n.

3 “Erfahrung ist nur durch die Vorstellung einer nothwendigen Verknüpfung der Wahrnehmungen möglich.” *KrV*, B 218.

mean, in particular, for a merely contingent sequence of perceptions (heat customarily following illumination by the sun) somehow to become necessary?

The key to answering this question, I believe, is that the necessity in question is characterized in Kant's official discussion of the *category* of necessity in both editions of the *Critique* (1781/1787). Here the three Postulates of Empirical Thought govern the categories of possibility, actuality, and necessity:

1. Whatever agrees with the formal conditions of experience (in accordance with intuition and concepts), is *possible*.
2. That which is connected with the material conditions of experience (of sensation), is *actual*.
3. That whose connection with the actual is determined in accordance with general conditions of experience is (exists) *necessarily*.⁴

The “formal [or “general”] conditions of experience” include the forms of intuition (space and time), together with the categories and principles of the understanding. And the “material” conditions of experience include that which is given to us, through sensation, in perception. Kant is thus describing a three-stage procedure in which we begin with the formal a priori conditions of the *possibility* of experience in general, perceive various *actual* events and processes by means of sensation, and then assemble these events and processes together in a unified experience via *necessary* connections using the general conditions of the possibility of experience with which we began.

In his detailed discussion of the third Postulate Kant makes it clear that he is referring, more specifically, to causal necessity and to particular (empirical) causal laws of nature. The third Postulate “pertains to material necessity in existence, and not the merely formal and logical necessity in the connection of concepts”.⁵ And this kind of necessity can “never be cognized from concepts but rather always only from the connection with that which is perceived, in accordance with general laws of experience”.⁶ Finally, since

4 “1. Was mit den formalen Bedingungen der Erfahrung (der Anschauung und den Begriffen nach) übereinkommt, ist möglich.

2. Was mit den materialen Bedingungen der Erfahrung (der Empfindung) zusammenhängt, ist wirklich.

3. Dessen Zusammenhang mit dem Wirklichen nach allgemeinen Bedingungen der Erfahrung bestimmt ist, ist (existirt) nothwendig.” KrV, A 218 /B 265f.

5 “[...] so geht es auf die materiale Nothwendigkeit im Dasein und nicht die bloß formale und logische in Verknüpfung der Begriffe”. KrV, A 226/B 279.

6 “[...] so kann die Nothwendigkeit der Existenz niemals aus Begriffen, sondern jederzeit nur aus der Verknüpfung mit demjenigen, was wahrgenommen wird, nach allgemeinen Gesetzen der Erfahrung erkannt werden.” KrV, A 227/ B 279.

there is no existence that could be cognized as necessary under the condition of other given appearances except the existence of effects from given causes in accordance with laws of causality, it is not the existence of things (substances) but of their state of which alone we can cognize their necessity, and moreover only from other states, which are given in perception, in accordance with empirical laws of causality.⁷

Kant is suggesting, therefore, that the necessity in question is precisely that of the causal connections among diverse events whose (objective) necessity Hume had denied.

Read against the background of the explicit discussion of Hume's skeptical doubts in the *Prolegomena*, Kant is also suggesting that the empirical regularities in question are themselves transformed from mere "empirical rules" into genuine "necessary and universally valid" laws by the same procedure. Thus, in the example from § 29 of the *Prolegomena* Kant begins from a mere empirical rule (that heat always follows illumination by the sun) and proceeds to a necessary and universally valid law by adding the a priori concept of cause to this (so far) merely inductive rule. The three-stage procedure described by the Postulates of Empirical Thought – in which we begin with the formal a priori conditions of the *possibility* of experience in general, perceive various *actual* events and processes by means of sensation, and then assemble these events and processes together in a unified experience via *necessary* connections using the general conditions of the possibility of experience with which we began – also results in a necessary and universally valid empirical causal laws of nature (the sun is through its light the cause of heat) governing the events and processes in question.

To be sure, Kant does not make clear exactly how the law that the sun is through its light the cause of heat becomes necessary and universally valid. He does not make clear exactly how this law acquires a more than merely inductive universality. A clearer case, however, is provided by the Newtonian law of universal gravitation – which Kant explicitly considers later in the *Prolegomena* (§ 37) as

7 "Da ist nun kein Dasein, was unter der Bedingung anderer gegebener Erscheinungen als notwendig erkannt werden könnte, als das Dasein der Wirkungen aus gegebenen Ursachen nach Gesetzen der Causalität. Also ist es nicht das Dasein der Dinge (Substanzen), sondern ihres Zustandes, wovon wir allein die Nothwendigkeit erkennen können und zwar aus anderen Zuständen, die in der Wahrnehmung gegeben sind, nach empirischen Gesetzen der Causalität." KrV, A 227/ B 279f.

an example, which is supposed to show that laws which we discover in objects of sensory intuition, especially if these laws have been cognized as necessary, are already held by us to be such as have been put there by the understanding, although they are otherwise in all respects like the laws of nature that we attribute to experience.⁸

The example is presented in the immediately following section (§ 38) as “a physical law of reciprocal attraction, extending to all material nature, the rule of which is that these attractions decrease inversely with the square of the distance from each point of attraction”.⁹

In order to see exactly how this example illustrates the way in which an empirical causal law can in fact become necessary and universally valid, we need also to consider Kant’s discussion in the *Metaphysical Foundations of Natural Science* (1786) – where the fourth chapter or Phenomenology corresponds to the Postulates of Empirical Thought. The role of this chapter, more specifically, is to explain how attributions of motion and rest to matter can be successively determined under the modal categories of possibility, actuality, and necessity – thereby resulting in a distinction between “true” and merely “apparent” motion.

Kant, on my reading, here develops a reconstruction of Newton’s “deduction from the phenomena” of the law of universal gravitation in Book 3 of the *Principia*.¹⁰ We begin, following Newton, from the observable “Phenomena” described by Kepler’s rules: the merely relative motions of the satellites in the solar system with respect to their primary bodies (the moon relative to the earth, the moons of Jupiter and Saturn relative to the planets in question, and the planets relative to the sun). We have not yet introduced a distinction between true and apparent motion, however, and so these Phenomena are so far mere “appearances” [*Er-*

8 “ein Beispiel [...], welches zeigen soll: daß Gesetze, die wir an Gegenständen der sinnlichen Anschauung entdecken, vornehmlich wenn sie als nothwendig | erkannt worden, von uns selbst schon für solche gehalten werden, die der Verstand hinein gelegt, ob sie gleich den Naturgesetzen, die wir der Erfahrung zuschreiben, sonst in allen Stücken ähnlich sind.” Prol, AA 04: 320.

9 “[...] physisches Gesetz der wechselseitigen Attraction, deren Regel ist, daß sie umgekehrt mit dem Quadrat der Entfernungen von jedem anziehenden Punkt eben so abnimmt [...]”. Prol, AA 04: 321.

10 This reading is developed most fully in my *Kant’s Construction of Nature: A Reading of the Metaphysical Foundations of Natural Science*. Cambridge 2013. For a more easily surveyable discussion (which I am generally following here) see my “The Prolegomena and Natural Science”. In: *Kant: Prolegomena. Ein gemeinschaftlicher Kommentar*. Ed. by Holger Lyre and Oliver Schliemann. Frankfurt 2012, 231–266.

scheinungen] that have not yet attained the status of “experience” [*Erfahrung*] (see MAN, AA 04: 554f.). The corresponding merely relative motions thus count (so far) as merely *possible*. At the next stage (again following Newton) we then use the law of inertia (Kant’s Second Law of Mechanics) to derive inverse-square (centripetal) accelerations of its satellites towards each primary body in the solar system (the moon towards the earth, the moons of Jupiter and Saturn towards their primary bodies, and so on): we now have true (as opposed to merely apparent) orbital rotations in each case, which hence now count as *actual*. At the third stage, finally, we show (once again following Newton) both that the accelerations in question are directly proportional to the quantities of matter of the corresponding primary bodies (so that the acceleration of the moon is proportional to the earth’s mass, those of the moons of Jupiter and Saturn are proportional to the masses of their primary bodies, and so on) and that such accelerations are also everywhere mutual between any two gravitationally interacting bodies (so that the earth accelerates towards the moon in turn, Jupiter and Saturn towards their satellites, and so on). Here, in accordance with the equality of action and reaction (Kant’s Third Law of Mechanics), we now have what Kant calls *necessary* equal and opposite motions, where the accelerations of any two gravitationally interacting bodies are oppositely directed and in inverse proportion to their masses.

In thus determining all the relevant motions in question as first possible, then actual, and finally necessary we have, by the same argument, also established the law of universal gravitation: each body experiences a gravitational acceleration towards every other body that is directly proportional to the mass of the body towards which it accelerates and inversely proportional to the square of the distance between them. And, since each of these mutual accelerations has just been determined as necessary in accordance with the Postulates of Empirical Thought, the law of universal gravitation has itself been determined as necessary in the same sense – relative, that is, to the initial Keplerian Phenomena from which we began. The law of universal gravitation, in other words, is determined in its connection with the actual in accordance with the general conditions of the possibility of experience: namely, the three Analogies of Experience as further specified by Kant’s three Laws of Mechanics. The point is that, whereas Kepler’s rules are (so far) merely inductive generalizations and, as such, are not yet grounded in a priori laws of the understanding, the law of universal gravitation is obtained by applying precisely such a priori laws to these Keplerian rules. And, in this way, the law of universal gravitation itself acquires a more than merely inductive material necessity. Kant’s reconstruction of Newton’s “deduction” of the law of universal gravitation from the initial Keplerian Phenomena thereby provides a perfect illustration of the three-step procedure suggested in the Postulates of Em-

pirical Thought whereby a mere empirical *rule* is transformed into a necessary and universally valid objective *law*.¹¹

2 The Second Edition Transcendental Deduction

Kant's reformulation of the Transcendental Deduction of the Categories in the second edition of the *Critique* culminates in the notoriously difficult § 26, entitled "Transcendental Deduction of the Universally Possible use in Experience of the Pure Concepts of the Understanding". In his introductory remarks Kant states the problem that he is now addressing as one of explaining

the possibility of knowing a priori, *by means of categories*, whatever objects *may present themselves to our senses*, not, indeed, with respect to the form of their intuition, but with respect to the laws of their combination – *and thus to prescribe the law to nature and even make nature possible* (latter emphasis added).¹²

Thus Kant here appears to be engaged with the same anti-Humean consideration of the necessity of (genuine) laws of nature that he had earlier articulated in the *Prolegomena*.

To be sure, Kant does not explicitly mention either Hume or the concept of necessary connection in these introductory remarks. But his discussion here, the remainder of § 26, and the concluding § 27 of the Deduction runs parallel, in several respects, to the corresponding discussion in the *Prolegomena*. Thus, Kant concludes § 36 of the *Prolegomena* with the striking claim: "*The understanding does not extract its laws (a priori) from, but prescribes them to, nature*".¹³ The introductory remarks in § 26, as we have just seen, clearly echo this claim. Similarly, § 36 of the *Prolegomena* asks: "How is nature possible in the *formal* sense, as

11 In an unpublished *Reflexion* (R 5414), written between the late 1770s and mid 1780s, Kant illustrates the transformation in question by precisely the transition from Kepler to Newton: "Empirically one can certainly discover rules, but not laws – as Kepler in comparison with Newton – for to the latter belongs necessity, and hence that they are cognized a priori. [Empirisch kan man wol regeln herausbringen, aber nicht Gesetze; wie Kepler im Vergleich mit Newton; denn zu den letzteren gehört nothwendigkeit, Mithin, daß sie *a priori* erkannt werden.]" (Ref1, AA 18: 176).

12 "Jetzt soll die Möglichkeit, *durch Kategorien* die Gegenstände, die nur immer *unseren Sinnen vorkommen mögen*, und zwar nicht der Form ihrer Anschauung, sondern den Gesetzen ihrer Verbindung nach *a priori* zu erkennen, also der Natur gleichsam das Gesetz vorzuschreiben und sie sogar möglich zu machen, erklärt werden." KrV, B 159f.

13 "[...] der Verstand schöpft seine Gesetze (*a priori*) nicht aus der Natur, sondern schreibt sie dieser vor." Prol, AA 04: 320.

the sum total of the rules to which appearances must be subject if they are to be thought as connected in one experience?”¹⁴ The remainder of § 26 of the Deduction investigates “the original ground of [nature’s] necessary lawfulness (as *natura formaliter spectata*)” [*Kategorien* [...] *von welchen die Natur* [...] *als dem ursprünglichen Grunde ihrer nothwendigen Gesetzmäßigkeit* (als *natura formaliter spectata*) *abhängt*] (KrV, B 165). What is most striking, however, is that the concluding § 27 rejects an alternative “*preformation-system* of pure reason” [Präformationsssystem *der reinen Vernunft*] (KrV, B 167). And Kant’s point is that, on this system, we would be left with only a “subjective necessity” attaching to the relation of cause and effect: “I would not be able to say that the effect is combined with the cause in the object (i.e., necessarily), but only that I am so constituted that I can think this representation in no other way than as so connected – precisely that which the skeptic most desires”.¹⁵ So Kant here appears to be countering specifically Humean skepticism with his own explanation of the ground for the objective necessity that he takes to be involved.¹⁶

We saw above that the *Prolegomena* presents the Newtonian law of universal gravitation as an example of how laws can be cognized as necessary even when “they are otherwise in all respects like the laws of nature that we attribute to experience”;¹⁷ this example is supposed to illustrate the “seemingly bold proposition” that the understanding prescribes laws to nature. Unlike in the *Prolegomena*, however, Kant does not explicitly mention the law of universal gravitation anywhere in the second edition Deduction – which proceeds, of course, at a much higher level of generality. Nevertheless, the relevance of Newton’s gravitational law even here is suggested in § 19 of the Deduction, which develops an account of the “*necessary unity*” belonging to the representations combined in any judgement as such – “i.e., a relation that is *objectively valid*, and is sufficiently

14 “Wie ist Natur in formeller Bedeutung, als der Inbegriff der Regeln, unter denen alle Erscheinungen stehen müssen, wenn sie in einer Erfahrung als verknüpft gedacht werden sollen, möglich?” Prol, AA 04: 318.

15 “Ich würde nicht sagen können: die Wirkung ist mit der Ursache im Objecte (d.i. nothwendig) verbunden, sondern ich bin nur so eingerichtet, daß ich diese Vorstellung nicht anders als so verknüpft denken kann; welches gerade das ist, was der Sceptiker am meisten wünscht [...]” KrV, B 168.

16 For an illuminating discussion see Pollok, Konstantin: “‘An Almost Single Inference’ – Kant’s Deduction of the Categories Reconsidered”. In: *Archiv für Geschichte der Philosophie* 90, 2008, 323–345, which discusses the second edition Deduction against the background of both the *Prolegomena* and the lengthy footnote to the Preface of the *Metaphysical Foundations* (MAN, 04: 474–476n) where Kant sketches a revised version of the Deduction already in 1786.

17 “[...] ob sie gleich den Naturgesetzen, die wir der Erfahrung zuschreiben, sonst in allen Stücken ähnlich sind.” Prol, AA 04: 320.

distinguished from the relation of precisely the same representations in which there would be only subjective validity, e.g., in accordance with laws of association”.¹⁸ Kant illustrates his point by the relation between subject and predicate in the judgement “Bodies are heavy” [*Körper sind schwer*] (ibid.). So this discussion continues the answer to Hume developed in the *Prolegomena*, and the particular example Kant chooses appears to invoke universal gravitation as discussed in both the *Prolegomena* and the *Metaphysical Foundations*.¹⁹

With these considerations in mind, let us now look briefly at the main argument of § 26. The introductory remarks quoted above about the categories prescribing the law to nature (see KrV, B 159) are immediately followed by: “For if [the categories] were not serviceable in this way, it would not become clear how everything that may merely be presented to our senses must stand under laws that arise a priori from the understanding alone”.²⁰ Kant begins, therefore, by emphasizing his fundamental distinction between sensibility and understanding: what has now to be explained is the possibility of cognizing a priori, by means of the pure concepts of the understanding, whatever may be presented to our sensibility. Why must our sensibility – our passive or receptive faculty for receiving sensory impressions – be in necessary harmony with our active or spontaneous faculty of intellectual thought, which, considered by itself, has no intrinsic relation to the particular pure forms of our (human) sensibility, that is, to space and time?

The crux of Kant’s argument depends on a distinction between space and time as “forms of intuition” and as “intuitions themselves”:

But space and time are represented a priori, not merely as forms of sensible intuition, but as intuitions themselves (which contain a manifold) and thus [represented a priori] with the determination of the unity of this manifold (see the Transcendental Aesthetic*). Therefore, unity of the synthesis of the manifold, outside us or in us, and thus a combination with which everything that is to be represented in space or time as determined must accord, is itself already given simultaneously, with (not in) these intuitions. But this synthetic unity can be

18 “[...] d.i. ein Verhältniß, das objectiv gültig ist und sich von dem Verhältnisse eben derselben Vorstellungen, worin bloß subjective Gültigkeit wäre, z.B. nach Gesetzen der Association, hinreichend unterscheidet.” KrV, B 142.

19 See especially the characterization of heaviness or weight in the latter work (MAN, 04: 518): “The action of the universal attraction immediately exerted by each matter on all matters, and at all distances, is called *gravitation*; the tendency to move in the direction of greater gravitation is called *weight*.” “Die Wirkung von der allgemeinen Anziehung, die alle Materie auf alle und in allen Entfernungen unmittelbar ausübt, heißt die Gravitation; die Bestrebung in der Richtung der größeren Gravitation sich zu bewegen ist die Schwere.”

20 “Denn ohne diese ihre Tauglichkeit würde nicht erhellen, wie alles, was unseren Sinnen nur vorkommen mag, unter den Gesetzen stehen müsse, die a priori aus dem Verstande allein entspringen.” KrV, B 160.

no other than that of the combination of the manifold of a given *intuition in general* in an original consciousness, in accordance with the categories, only applied to our *sensible intuition*. Consequently all synthesis, even that whereby perception becomes possible, stands under the categories, and, since experience is knowledge through connected perceptions, the categories are conditions of the possibility of experience, and hence are a priori valid for all objects of experience.²¹

Thus, although Kant begins by reminding us that space and time are unified or unitary representations in a sense already articulated in the Aesthetic, he then appears to claim that this same synthetic unity is actually due to the understanding rather than sensibility. It is for precisely this reason, it appears, that we can now conclude that the pure categories of the understanding are in fact “a priori valid for all objects of [sensible] experience” (*gelten also a priori auch von allen Gegenständen der [sinnlichen] Erfahrung*; KrV, B 161).

The footnote appended to the reference back to the Aesthetic begins by invoking the example of geometry:

Space represented as *object* (as is actually required in geometry) contains more than the mere form of intuition – namely, [it contains] the *grasping together* [*Zusammenfassung*] of the manifold, given in accordance with the form of sensibility, in an *intuitive* representation, so that the *form of intuition* gives merely a manifold, but the *formal intuition* [also] gives unity of representation.²²

21 “Wir haben *Formen* der äußeren sowohl als inneren sinnlichen Anschauung *a priori* an den Vorstellungen von Raum und Zeit, und diesen muß die Synthesis der Apprehension des Mannigfaltigen der Erscheinung jederzeit gemäß sein, weil sie selbst nur nach dieser Form geschehen kann. Aber Raum und Zeit sind nicht bloß als *Formen* der sinnlichen Anschauung, sondern als *Anschauungen* selbst (die ein Mannigfaltiges enthalten), also mit der Bestimmung der *Einheit* dieses Mannigfaltigen in ihnen *a priori* vorgestellt (siehe transsc. Ästhet.). Also ist selbst schon *Einheit der Synthesis* des Mannigfaltigen außer oder in uns, mithin auch eine *Verbindung*, der alles, was im Raume oder der Zeit bestimmt vorgestellt werden soll, gemäß sein muß, *a priori* als Bedingung der Synthesis aller *Apprehension* schon mit (nicht in) diesen Anschauungen zugleich gegeben. Diese synthetische Einheit aber kann keine andere sein, als die der Verbindung des Mannigfaltigen einer gegebenen *Anschauung überhaupt* in einem ursprünglichen Bewußtsein, den Kategorien gemäß, nur auf unsere *sinnliche Anschauung* angewandt. Folglich steht alle Synthesis, wodurch selbst Wahrnehmung möglich wird, unter den Kategorien; und da Erfahrung Erkenntniß durch verknüpfte Wahrnehmungen ist, so sind die Kategorien Bedingungen der Möglichkeit der Erfahrung und gelten also *a priori* auch von allen Gegenständen der Erfahrung.” KrV, B 160f.

22 “Der Raum, als *Gegenstand* vorgestellt (wie man es wirklich in der Geometrie bedarf), enthält mehr als bloße Form der Anschauung, nämlich *Zusammenfassung* des mannigfaltigen nach der Form der Sinnlichkeit Gegebenen in eine *anschauliche* Vorstellung, so daß die *Form der Anschauung* bloß Mannigfaltiges, die *formale Anschauung* aber Einheit der Vorstellung giebt.” KrV, B 160n.

But the rest of the note leaves us puzzled about the precise relationship between the understanding and sensibility:

In the Aesthetic I counted this unity [as belonging] to sensibility, only in order to remark that it precedes all concepts, although it in fact presupposes a synthesis that does not belong to the senses but through which all concepts of space and time first become possible. For, since through it (in that the understanding determines sensibility) space or time are first *given*, the unity of this a priori intuition belongs to space and time, and not to the concept of the understanding (§ 24).²³

The “unity of representation” mentioned in the first sentence appears to be the “all-encompassing” [*allbefassenden*] unity of space discussed in the third paragraph of the Metaphysical Exposition of Space (see KrV, A 24f./B 39), the point of which is to argue that space is an *intuitive* rather than *conceptual* representation. The second sentence confirms this idea, but also emphasizes that the unity in question presupposes a distinctively *non-sensible* synthesis. The third sentence, however, appears to take this back, and even to contradict itself; for, after reiterating that the synthetic unity in question is a product of the understanding, Kant appears to deny that it is due to the understanding after all.

I have attempted to resolve these puzzles in the course of my evolving work on Kant’s theory of geometry.²⁴ I cannot repeat my arguments here, however, so I shall simply state my conclusions. Space as our pure form of intuition is the manifold or aggregate of all possible (oriented) perspectives or points of view in accordance with which a merely receptive or perceiving subject can be affected (along a line of sight, as it were) by any possible object of outer sense. Space as itself a (single and unified) object of intuition or formal intuition, however, can only arise when we add the further condition that such a merely receptive perceiving subject is also a thinking subject with an active faculty of understanding. In particular, since the *I think* that must be able to accompany all my represen-

23 “Diese Einheit hatte ich in der Ästhetik bloß zur Sinnlichkeit gezählt, um nur zu bemerken, daß sie vor allem Begriffe vorhergehe, ob sie zwar eine Synthesis, die nicht den Sinnen angehört, durch welche aber alle Begriffe von Raum und Zeit zuerst möglich werden, voraussetzt. Denn da durch sie (indem der Verstand die Sinnlichkeit bestimmt) der Raum oder die Zeit als Anschauungen zuerst *gegeben* werden, so gehört die Einheit dieser Anschauung *a priori* zum Raume und der Zeit und nicht zum Begriffe des Verstandes (§ 24).” KrV, B 160f.n.

24 See “Geometry, Construction, and Intuition in Kant and his Successors”. In: *Between Logic and Intuition: Essays in Honor of Charles Parsons*. Ed. by Gila Scher and Richard Tieszen. Cambridge 2000, 186–218; “Kant on Geometry and Spatial Intuition”. In: *Synthese* 186, 2012, 231–255; “Space and Geometry in the B Deduction”. In: *Kant’s Philosophy of Mathematics*. Ed. by Carl Posey and Ofra Rechter. Cambridge. Forthcoming.

tations is always “one and the same” [*ein und dasselbe*] (KrV, B 132), it follows that every possible object of outer sense must be perceivable by the same perceiving subject. And this implies, in turn, that any (oriented) perspective in the manifold constituting space as a mere form of intuition must be reachable by a continuous (rigid) motion (involving both translations and rotations) from any other. It is only in this way, on my reading, that we obtain space as a single unified object – and, more specifically, as that which is presupposed by the science of geometry.²⁵

It is important to appreciate, however, that space as a single object of intuition is not itself an object of geometry. Whereas space as such an object is all-encompassing and infinite, the objects of Euclidean geometry, for Kant, comprise a system of bounded figures, each of which is generated by a finite number of iterations of Euclidean constructions within the single all-encompassing space. These bounded figures, however, are only possible as parts of space as a single unified whole, and so the latter is a necessary presupposition or precondition for the possibility of the objects of Euclidean geometry. In particular, since the schemata or constructions of geometrical concepts (those of line segment, circle, triangle, and so on) thereby presuppose the single all-encompassing unity of space as a single whole, the synthesis of the understanding responsible for this unity (in accordance with the argument of § 26) is prior to the schematization of any geometrical concept. Indeed, one can also see (by enumeration) that it is prior to the schematization of any pure concept of the understanding as well, and it is therefore prior to the schematization of any concept whatsoever – mathematical, categorical, or empirical.

In sum, the application of the transcendental unity of apperception (the most fundamental synthetic unity of which the understanding is capable) results in space as a single unified object of intuition in which all possible geometrical constructions and all possible objects of outer (sensible) intuition are contained.

²⁵ What Kant is suggesting here, on my reading, is analogous to the celebrated Helmholtz-Lie Theorem, which shows how the metrical structure of any Riemannian manifold of constant curvature is determined by the group-theoretic structure of rigid motions coordinating the tangent spaces at every point. What I am calling a “perspective” at a given point is represented by an (oriented) triple of (linearly independent) tangent vectors at the point. But since, for Kant, the only possible metrical structure is Euclidean, there is not even a more general class of spaces of constant curvature (let alone any spatial manifolds of *variable* curvature). So there is no deep mathematical result involved in Kant’s conception – only the observation (from a modern point of view) that the fundamental Euclidean constructions (of lines and circles) are generated by the Euclidean group of rigid motions. See especially the first of the papers cited in the previous note for the relationship between Kant’s conception of the role of motion in geometry and the Helmholtz-Lie Theorem; the second two papers then trace out the connection between this conception and the argument of § 26 of the B Deduction.

Space as such a unified object results from the requirement that the perceiving self is also a thinking self in accordance with the possibility of continuous rigid motions connecting any perspective with any other. This possibility, in turn, enables Euclidean constructions in any part of space and, at the same time, the application of Euclidean geometry to any given (empirical) objects encountered anywhere in outer sense. And, since the possibility of continuous (rigid) motions connecting any perspective with any other is prior to the application of any particular concept (mathematical, categorial, or empirical), Kant is perfectly within his rights, in the problematic footnote to § 26, in asserting that the unity constitutive of space (as a formal intuition) “precedes all *concepts*, although it in fact presupposes a synthesis that does not belong to the senses but through which all *concepts* of space and time first become possible” [*daß sie vor allem Begriffe vorhergehe, ob sie zwar eine Synthesis, die nicht den Sinnen angehört, durch welche aber alle Begriffe von Raum und Zeit zuerst möglich werden, voraussetzt*. KrV, B 161n; emphasis added). He is also within his rights, in the following sentence, in asserting that “the unity of this a priori intuition belongs to space and time, and not to the *concept* [i.e., category – MF] of the understanding (§ 24)” [*so gehört die Einheit dieser Anschauung a priori zum Raume und der Zeit und nicht zum Begriffe des Verstandes* (§ 24)] (ibid.; emphasis added).²⁶

Moreover, if we follow the reference of this last sentence back to § 24, we find that Kant introduces the “figurative synthesis” [*figürliche Synthesis*] or “transcendental synthesis of the imagination” [*transscendentale Synthesis der Einbildungskraft*] as “an action of the understanding on sensibility and its *first* application (at the same time the ground of all the rest) to objects of the intuition possible for us” (emphasis added).²⁷ And what is most important here is that Kant illustrates this “action” by both (Euclidean) geometrical constructions (of lines and circles) and the act of “*drawing* a straight line (which is to be the outer figu-

²⁶ Whereas, on the modern group-theoretical point of view of the previous note, space as a whole is the object of a (group-theoretical) geometrical concept, this is emphatically not the case in Kant’s traditional Euclidean conception – where the only objects of geometrical concepts are finite bounded figures such as line segments and circles. Similarly, whereas the conception of a “perspective” in the previous note presupposes, from a modern point of view, the concept of straight line (of a three-dimensional affine space), this is again not the case from Kant’s Euclidean point of view. Thus, since no particular concepts are involved here, the transition from space as a mere form of intuition to space as a formal intuition, for Kant, corresponds only to the need for the (active) spontaneity of the understanding *in general* to unify or synthesize what is (passively) given by the receptive faculty of sensibility.

²⁷ “[...] Wirkung des Verstandes auf die Sinnlichkeit und die erste Anwendung desselben (zugleich der Grund aller übrigen) auf Gegenstände der uns möglichen Anschauung [...]” KrV, B 152.

rative representation of *time*)” (latter emphasis added)²⁸ – which “*drawing*”, Kant suggests, should be considered as “*motion*, as action of the subject (not as determination of an object*)” (latter emphasis added).²⁹ Thus the motion involved in the “outer figurative representation of time” underlies the representation of time as a formal intuition as well as space – or, perhaps better, the representation of both space and time (together) as formal intuitions. In the appended footnote, in particular, Kant says that the relevant kind of motion (as an action of the subject rather than a determination of an object),

is a pure act of successive synthesis of the manifold in outer intuition in general through the productive imagination, and it belongs not only to geometry [i.e., in the construction of geometrical concepts – MF], but *even to transcendental philosophy* [presumably, in the unification of the whole of space, and time, as formal intuitions – MF].³⁰ (emphasis added).

Finally, although the precise sense in which this “outer figurative representation of time” yields a representation of time as a formal intuition is delicate, the emphasis on motion in this discussion points towards a connection between the fundamental figurative synthesis by which the understanding first acts on sensibility and the Newtonian mathematical theory of motion. In the *Metaphysical Exposition of Time* added to the second edition *Aesthetic*, for example, Kant considers a new mathematical science – not mentioned in the first edition – called the “general doctrine of motion” [*allgemeine Bewegungslehre*]: “[O]ur concept of time explains as much synthetic a priori knowledge as is set forth in the general doctrine of motion, which is by no means unfruitful”.³¹ Moreover, Kant explains in the Preface to the *Metaphysical Foundations* that the natural science for which he is providing a foundation is “either a pure or an applied *doctrine of motion*” [*reine oder angewandte Bewegungslehre*] (MAN, AA 04: 476), and he concludes by saying that he wants to bring his enterprise “into union with the mathematical doctrine of motion” [*mit der mathematischen Bewegungslehre in Vereinigung zu bringen*] (MAN, AA 04: 478) – which (he strongly suggests) is paradigmatically articulated in Newton’s *Principia*. So there appears to be very little doubt that one of

28 “Ziehen einer geraden Linie (die die äußerlich figürliche Vorstellung der Zeit sein soll)” KrV, B 154.

29 “Bewegung als Handlung des Subjects (nicht als Bestimmung eines Objects)*” KrV, B 154 f.

30 “[...] ist ein reiner Actus der successiven Synthesis des Mannigfaltigen in der äußeren Anschauung überhaupt durch productive Einbildungskraft und gehört nicht allein zur Geometrie, sondern sogar zur Transscendentalphilosophie.” KrV, B 155n.

31 “Also erklärt unser Zeitbegriff die Möglichkeit so vieler synthetischer Erkenntniß *a priori*, als die allgemeine Bewegungslehre, die nicht wenig fruchtbar ist, darlegt.” KrV, B 49.

the reasons for which Kant introduces the outer figurative representation of time in the second edition version of the Deduction is to suggest that the original application of the transcendental unity of apperception to both space and time serves to ground not only the possibility of applying Euclidean geometry to all objects of outer sense but also that of a parallel and complementary application of Newtonian physics.

3 The *Critique of the Power of Judgement*

I have argued that Kant takes the law of universal gravitation to be exemplary of the (empirical or material) necessity possessed by particular empirical causal laws and that the relevant kind of necessity is that of the official category of necessity discussed in the Postulates of Empirical Thought. And I have argued that this kind of necessity of empirical causal laws is at issue in the second edition Transcendental Deduction as well. Here I am in disagreement with the suggestion of Gerd Buchdahl and others that the necessity in question does not at all arise from the constitutive activities of the understanding but only from the purely regulative activities of reason and reflective judgement.³² On this view, in particular, only the *systematicity* of empirical laws under the guidance of reason and reflective judgement can give rise to causal necessity – where this systematicity, in turn, is largely independent of the constitutive activities of the understanding. On my view, by contrast, the constitutive use of the understanding is always crucially involved, and the problem addressed by the regulative use of reason and reflective judgement is rather that only the law of universal gravitation has so far been constitutively grounded – where this grounding, as we have seen, essentially depends on the conception of pure natural science that Kant articulates in both the *Prolegomena* and *Metaphysical Foundations*.³³

I believe that a careful reading of the discussion in the third *Critique* of the newly distinguished faculty of reflective judgement strongly supports my view – and that it sheds additional light, as well, on the transcendental synthesis of the imagination discussed in the second edition Deduction. An adequate treatment,

³² See especially Buchdahl, Gerd: *Metaphysics and the Philosophy of Science: The Classical Origins Descartes to Kant*. Oxford 1969.

³³ Kant represents this same conception in the Introduction to the second edition of the *Critique* (KrV, B 17–21) – the examples presented there of synthetic a priori propositions of “pure natural science” are the three Laws of Mechanics of the *Metaphysical Foundations*: the conservation of the total quantity of matter, inertia, and the equality of action and reaction.

however, would require a lengthy essay of its own, and so I shall here confine myself to preliminary suggestions for reading a number of important passages.

Kant begins his discussion of judgement as an “a priori legislative faculty” in § IV of the (published) Introduction to the third *Critique*. After asserting that “the determining power of judgement under universal transcendental laws, given by the understanding” [*Die bestimmende Urtheilskraft unter allgemeinen transscendentalen Gesetzen, die der Verstand giebt*] (KU, AA 05: 179) is not problematic (for these laws are already given – constitutively – by the understanding), Kant forcefully raises the problem of particular empirical laws:

But there is such a multiplicity of forms in nature, as it were so many modifications of the universal transcendental concepts of nature that are left undetermined by those laws that the pure understanding gives a priori, since these pertain only to the possibility of a nature (as object of the senses) in general, that there must nevertheless also be laws for it which, as empirical, may seem to be contingent in accordance with the insight of *our* understanding, but which if they are to be called laws (as is also required by the concept of nature), must be regarded as necessary on a principle of the unity of the manifold, even if that principle is unknown to us.³⁴

Kant then states the new synthetic a priori principle of reflective judgement for the first time:

Since universal laws of nature have their ground in our understanding, which prescribes them to nature (although only in accordance with the universal concept of it as nature), the particular empirical laws, in regard to that which is left undetermined in them by the former, must be considered in terms of the sort of unity they would have if an understanding (even if not ours) had likewise given them for the sake of our faculty of cognition, in order to make possible a system of experience in accordance with particular laws of nature.³⁵

34 “Allein es sind so mannigfaltige Formen der Natur, gleichsam so viele Modificationen der allgemeinen transscendentalen Naturbegriffe, die durch jene Gesetze, welche der reine Verstand *a priori* giebt, weil dieselben nur auf die Möglichkeit einer Natur (als Gegenstandes der Sinne) überhaupt gehen, unbestimmt gelassen werden, daß dafür doch auch Gesetze sein müssen, die zwar als empirische nach *unserer* Verstandeseinsicht zufällig sein mögen, die aber doch, wenn sie Gesetze heißen sollen (wie es auch der Begriff einer Natur erfordert), aus einem, wenn gleich uns unbekanntem, Princip der Einheit des Mannigfaltigen als nothwendig angesehen werden müssen.” KU, AA 05: 179f.

35 “Nun kann dieses Princip kein anderes sein als: daß, da allgemeine Naturgesetze ihren Grund in unserem Verstande haben, der sie der Natur (obzwar nur nach dem allgemeinen Begriffe von ihr als Natur) vorschreibt, die besondern empirischen Gesetze in Ansehung dessen, was in ihnen durch jene unbestimmt gelassen ist, nach einer solchen Einheit betrachtet werden müssen, als ob gleichfalls ein Verstand (wenn gleich nicht der unsrige) sie zum Behuf unserer Erkenntnißvermögen, um ein System der Erfahrung nach besonderen Naturgesetzen möglich zu machen, gegeben hätte.” KU, AA 05: 180.

Because this principle essentially contains the concept of an end or purpose of such an understanding (namely, to arrange nature so that it is comprehensible, at least in principle, by *our* understanding), Kant calls his new principle that of “the *purposiveness of nature* in its multiplicity” [Zweckmäßigkeit der Natur in ihrer Mannigfaltigkeit] (ibid.).

The following § V is entitled “The principle of the formal purposiveness of nature is a transcendental principle of the power of judgement.” Kant again begins by considering determinative judgement under universal laws of the understanding. And he again proceeds to consider particular empirical laws, although this time considered as more determinate specifications of the universal principle of *causality*:

[S]pecifically distinct natures, besides that which they have in common as belonging to nature in general, can still be causes in infinitely many ways; and each of these ways must (in accordance with the concept of a cause in general) 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 in no way comprehend this necessity.³⁶

We must, therefore, consider “the possibility of experience (as a system in accordance with empirical laws) as contingent” (ibid.). Nevertheless:

[S]ince such a unity must still necessarily be presupposed and assumed, for otherwise no thoroughgoing interconnection of empirical cognitions into a whole of experience would take place, because the universal laws of nature yield such an interconnection of things with respect to their genera, as things in nature in general, but not specifically, as such and such particular beings in nature, the power of judgement must thus assume it as an a priori principle for its own use that what is contingent for human insight in the particular (empirical) laws of nature nevertheless contains a lawful unity – which, to be sure, is not fathomable by us but still thinkable – in the combination of the manifold into one whole of experience possible in itself.³⁷

36 “[...] so daß spezifisch-verschiedene Naturen außer dem, was sie als zur Natur überhaupt gehörig gemein haben, noch auf unendlich mannigfaltige Weise Ursachen sein können; und eine jede dieser Arten muß (nach dem Begriffe einer Ursache überhaupt) ihre Regel haben, die Gesetz ist, mithin Nothwendigkeit bei sich führt: ob wir gleich nach der Beschaffenheit und den Schranken unserer Erkenntnißvermögen diese Nothwendigkeit gar nicht einsehen.” KU, AA 05: 183.

37 “Weil aber doch eine solche Einheit nothwendig vorausgesetzt und angenommen werden muß, da sonst kein durchgängiger Zusammenhang empirischer Erkenntnisse zu einem Ganzen der Erfahrung Statt finden würde, indem die allgemeinen Naturgesetze zwar einen solchen Zusammenhang unter den Dingen ihrer Gattung nach, als Naturdingen überhaupt, aber nicht spezifisch, als solchen besonderen Naturwesen, an die Hand geben: so muß die Urtheilskraft für ihren eigenen Gebrauch es als Princip *a priori* annehmen, daß das für die menschliche Einsicht

Although our insight will never get to the bottom of the “lawful unity” underlying the particular empirical laws of nature, we must assume that such unity is there to be found – and we can, and indeed must, therefore seek to find it.

Now it might appear that the pure natural science grounded in the *Metaphysical Foundations* has no place here, since Kant only speaks of universal transcendental principles of the understanding (such as the law of causality), on the one side, and particular empirical (causal) laws into which we as yet have no a priori insight, on the other. That this is not the case, however, is indicated at the very beginning of this section, where Kant distinguishes between two different types of synthetic a priori principles:

A transcendental principle is that through which is represented a priori the universal condition under which alone things can be objects of our cognition in general. By contrast, a principle is called metaphysical if it represents a priori the condition under which alone objects, whose concept must be empirically given, can be further determined a priori. Thus, the principle of the cognition of bodies as substances and as changeable substances is transcendental, if it is thereby asserted that their changes must have a cause; it is metaphysical, however, if it is thereby asserted that their changes must have an *external* cause.³⁸

Kant is here referring to the way in which the *Metaphysical Foundations* further specifies the pure concept of substance via the empirical concept of matter or body – the very highest empirical concept of all natural science. And the restriction of the general principle of causality to specifically external causes then follows as Kant’s Second Law of Mechanics.³⁹

Zufällige in den besonderen (empirischen) Naturgesetzen dennoch eine für uns zwar nicht zu ergründende, aber doch denkbare gesetzliche Einheit in der Verbindung ihres Mannigfaltigen zu einer an sich möglichen Erfahrung enthalte.” KU, AA 05: 183f.

38 “Ein transscendentales Princip ist dasjenige, durch welches die allgemeine Bedingung *a priori* vorgestellt wird, unter der allein Dinge Objecte unserer Erkenntniß überhaupt werden können. Dagegen heißt ein Princip metaphysisch, wenn es die Bedingung *a priori* vorstellt, unter der allein Objecte, deren Begriff empirisch gegeben sein muß, *a priori* weiter bestimmt werden können. So ist das Princip der Erkenntniß der Körper als Substanzen und als veränderlicher Substanzen transscendental, wenn dadurch gesagt wird, daß ihre Veränderung eine Ursache haben müsse; es ist aber metaphysisch, wenn dadurch gesagt wird, ihre Veränderung müsse eine *äußere* Ursache haben [...]”. KU, AA 05: 181.

39 Compare the formulation in the *Metaphysical Foundations* (MAN, AA 04: 543): “All changes of matter have an external cause.” [Alle Veränderung der Materie hat eine äußere Ursache.] Kant begins the following proof with the (parenthetical) statement (ibid.): “From general metaphysics [i.e., transcendental philosophy – MF] we take as basis the proposition that every change has a cause, and here it is only to be proved of matter that its change must always have an *external cause*.” [Aus der allgemeinen Metaphysik wird der Satz zum Grunde gelegt, daß alle Veränderung eine Ursache habe; hier soll von der Materie nur bewiesen werden, daß ihre Veränderung

The importance of the *Metaphysical Foundations* in this connection is further supported by Kant's later discussion in the Antinomy of the Power of Judgement, which involves an apparent conflict between two (regulative) maxims of reflective judgement: one according to which "[a]ll generation of material things and their forms must be judged as possible in accordance with merely mechanical laws",⁴⁰ the other according to which "[s]ome products of material nature cannot be judged as possible according to merely mechanical laws (judging them requires an entirely different law of causality, namely that of final causes)".⁴¹ Moreover, as Kant suggests in preparatory remarks to his solution of the Antinomy, the mechanical laws mentioned in the thesis are connected to the conception of inertia articulated in the *Metaphysical Foundations*: "[T]he possibility of a living matter (whose concept contains a contradiction, because lifelessness, *inertia*, constitutes the essential character of matter) cannot even be thought."⁴² Thus Kant here alludes, once again, to the way in which his Second Law of Mechanics restricts the universal principle of causality to specifically external causes, and his point is that the maxim of always seeking mechanical causes is to be followed (as a regulative principle of reflective judgement) because it is only in this way that we can even hope to gain insight into the causal necessity of particular empirical laws.⁴³

Kant's allusions to the *Metaphysical Foundations* help us better to appreciate what is distinctive in Kantian pure natural science – namely, that it involves a *mathematically exact realization* of the pure categories and principles of the

jederzeit eine äußere Ursache haben müsse.] In the following remark Kant explains that the inertia of matter therefore consists in its essential *lifelessness* – where a living substance, by contrast, can "determine itself to act from an *internal principle*" [sich aus einem inneren Princip zum Handeln [...] zu bestimmen] (MAN, AA 04: 544).

40 "Alle Erzeugung materieller Dinge und ihrer Formen muß als nach bloß mechanischen Gesetzen möglich beurtheilt werden." KU, AA 05: 387.

41 "Einige Producte der materiellen Natur können nicht als nach bloß mechanischen Gesetzen möglich beurtheilt werden (ihre Beurtheilung erfordert ein ganz anderes Gesetz der Causalität, nämlich das der Endursachen)." KU, AA 05: 387.

42 "Aber die Möglichkeit einer lebenden Materie (deren Begriff einen Widerspruch enthält, weil Lebloßigkeit, *inertia*, den wesentlichen Charakter derselben ausmacht) läßt sich nicht einmal denken [...]" KU, AA 05: 394.

43 I am not suggesting that mechanical explanation in the Antinomy of Teleological Judgement is *identical* to causal explanation in the sense of the Second Law of Mechanics, but only that the two are connected in such a way that explanations in accordance with Kant's Second Law are *paradigmatic* of mechanical explanations as discussed in the Antinomy. For a careful and detailed discussion of the meaning of "mechanical" in the Antinomy see McLaughlin, Peter: "Mechanical Explanation in the 'Critique of the Power of Teleological Judgment'". In: *Kant's Theory of Biology*. Ed. by Ina Goy and Eric Watkins. Berlin 2014, 149–166.

understanding.⁴⁴ For the Analogies of Experience, in the *Metaphysical Foundations*, are realized by the quantitative conservation of the total quantity of matter, the quantitative conservation of momentum in all actions (exertions) of causality, and the quantitative equality of action and reaction in all causal mutual interactions. And it is in precisely this way that we obtain mathematically exact realizations of the categories of substance, causality, and community. So what Kant requires for full insight into causal necessity, on my reading, is that both the given causally acting (interacting) substances and the given causal actions (interactions) of these substances be thus mathematically representable in accordance with the Analogies of Experience. Newton, as Kant understands him, has achieved precisely this in the case of the law of universal gravitation, so that we have thereby achieved full insight into the necessity of at least one especially fundamental empirical causal law.

In the case of other empirically given exercises of causality, by contrast, our a priori insight – both categorial and mathematical – is much less determinate. This does not mean, however, that we have no insight at all. Kant discusses causal actions involving light, for example, in the first *Critique*, *Prolegomena*, *Metaphysical Foundations*, and third *Critique*. He takes the behavior of light to be governed by the laws of reflection and refraction, and also by the photometric law that the same quantum of illumination spreads out from a central source uniformly on spherical surfaces, so that the degree (intensity) of illumination on any portion of such a surface is directly proportional to its area and inversely proportional to the square of the distance from the center.⁴⁵ Kant is using this law in his example of how one can apply mathematics to appearances by composing “the degree of the sensations of sunlight out of approximately 200,000 illuminations of the moon” [*Grad der Empfindungen des Sonnenlichts aus etwa 200000 Erleuchtungen durch den Mond*] in the first *Critique* (KrV, A 179/B 221).⁴⁶ And he may also have it in mind in his discussion of the stone becoming warm due to illumination by the sun in

44 This is how I read the important paragraph in the Preface to the *Metaphysical Foundations* on the need for the mathematical construction of (empirical) concepts in any “special metaphysical natural science” (*besondere metaphysische Naturwissenschaft*) (MAN, AA 04: 470). I articulate and defend this reading in detail in *Kant’s Construction of Nature* (note 3 above).

45 Kant discusses this law in the Dynamics of the *Metaphysical Foundations* (Prol, AA 04: 518–521), where, in particular, he stresses its similarity with the inverse-square law of universal gravitation. He also discusses Euler’s wave theory of light (Prol, AA 04: 519–520n) – which, as we shall see in a moment, plays a significant role in the third *Critique* as well.

46 In particular, the (approximate) value of 200,000 results from comparing the distance from the sun to the earth-moon system, the distance from the moon to the earth, and the (circular) area of the moon in accordance with the inverse-square photometric law.

the *Prolegomena* (see Prol, AA 04: 312).⁴⁷ In such cases, I believe, Kant reasonably takes us thereby to be justified in ascribing causal necessity to the laws in question – if only tentatively and provisionally.⁴⁸

There is an especially striking discussion of light in the “Critique of the Power of Aesthetic Judgement”. Kant has just been emphasizing that the pure judgement of taste must depend only on spatio-temporal *form* and not on merely *material* features of sensations such as colors and tones. But he now finds a way to qualify this assertion in the context of Euler’s theories of light and sound:

If one assumes, with Euler, that colors are vibrations (*pulsus*) of the aether immediately following one another, just as tones are vibrations in the air disturbed by sound, and, what is most important, that the mind does not merely perceive, by sense, their effect on the animation of the organ, but also, by reflection, perceives the regular play of the impressions (hence the form in the combination of different representations) (about which I have very little doubt), then colors and tones would not be mere sensations, but would already be a formal determination of the unity of the manifold in them, and in that case could also be counted as beauties in themselves.⁴⁹

47 Here one would need a further mathematical connection between degree of illumination and heat. Kant may here have in mind Carl Wilhelm’s Scheele’s theory of radiant heat, based on the discovery that this kind of heat (which we now conceive as electromagnetic radiation) is propagated in accordance with the optical laws of reflection and refraction.

48 Compare the discussion in the System of Principles of Pure Understanding: “Even laws of nature, when they are considered as principles of the empirical use of the understanding, at the same carry with themselves an expression of necessity, and thus at least the suggestion of a determination from grounds that are valid a priori and antecedent to all experience.” [Selbst Naturgesetze, wenn sie als Grundsätze des empirischen Verstandesgebrauchs betrachtet werden, führen zugleich einen Ausdruck der Nothwendigkeit, mithin wenigstens die Vermuthung einer Bestimmung aus Gründen, die *a priori* und vor aller Erfahrung gültig sind, bei sich.] KrV, A 159/ B 198.

49 “Nimmt man mit *Eulern* an, daß die Farben gleichzeitig auf einander folgende Schläge (*pulsus*) des Äthers, so wie Töne der im Schalle erschütterten Luft sind, und, was das Vornehmste ist, das Gemüth nicht bloß durch den Sinn die Wirkung davon auf die Belebung des Organs, sondern auch durch die Reflexion das regelmäßige Spiel der Eindrücke (mithin die Form in der Verbindung verschiedener Vorstellungen) wahrnehme (woran ich doch gar nicht zweifle): so würde Farbe und Ton nicht bloße Empfindungen, sondern schon formale Bestimmung der Einheit eines Mannigfaltigen derselben sein und alsdann auch für sich zu Schönheiten gezählt werden können.” KU, AA 05: 224. My interest in this passage was sparked by a presentation on “Kant on Color and Form” by Ludmila Guenova at the Ninth Annual Meeting of the Eastern Study Group of the North American Kant Society at Princeton on April 28, 2012. The parenthetical clause at the end of the passage – “about which I have very little doubt [*woran ich doch gar nicht zweifle*]” – was added in the third (1799) edition; the first (1790) and second (1793) editions have “which I very much doubt” (*woran ich doch gar sehr zweifle*). What is important here, however, is only that Kant takes the suggested way of viewing colors and sounds as “beauties in themselves” to be a *possible* one, and, in either case, he closely ties properly aesthetic judgements to pure spatio-temporal forms as exemplified in Euler’s theories.

Taking Euler's wave theories of light and sound seriously, in other words, gives Kant a possible way for considering even colors and tones as manifestations of pure spatio-temporal form.

The pure judgement of taste, Kant holds, is not appropriately applied to "geometrically regular figures" (see KU, AA 05: 241–243), where the schematism of the imagination is determinately constrained by a corresponding geometrical concept. Yet the activity of the imagination involved in a judgement of taste must still proceed in harmony with the faculty of understanding *in general*, for otherwise we would have no basis for taking our pleasure in the beautiful to be universally communicable:

[S]ince the freedom of the imagination consists precisely in the fact that it schematizes without a concept, the judgement of taste must rest on a mere sensation of the reciprocally enlivening imagination in its *freedom* and understanding with its *lawfulness*, thus on a feeling that allows the object to be judged in accordance with the purposiveness of the representation (by which an object is given) for the promotion of the faculty of cognition in its free play; and taste, as a subjective power of judgement, contains a principle of subsumption, not of the intuition under *concepts*, but of the *faculty* of intuitions or presentations (i.e., of the imagination) under the *faculty* of concepts (i.e., the understanding), in so far as the former *in its freedom* is in harmony with the latter *in its lawfulness*.⁵⁰

It is in this way, Kant suggests, that our distinctive aesthetic pleasure in the beautiful serves, at the same time, to strengthen and maintain the cognitive use of reflective judgement in guiding our ascent from given sensible particulars to ever more general empirical concepts and laws. And so, applied to the above case of colors and sounds, it appears that they, too, may count as "free beauties" (see KU, AA 05: 229–231, 243) to the extent that we can become conscious, in their perception, of an open-ended striving of the imagination to find an appropriate mathematical representation of them (such as the one proposed in Euler's theories) – without, however, having yet arrived at any *determinate* such concept.

50 "D.i. weil eben darin, daß die Einbildungskraft ohne Begriff schematisirt, die Freiheit derselben besteht: so muß das Geschmacksurtheil auf einer bloßen Empfindung der sich wechselseitig belebenden Einbildungskraft in ihrer *Freiheit* und des Verstandes mit seiner *Gesetzmäßigkeit*, also auf einem Gefühle beruhen, das den Gegenstand nach der Zweckmäßigkeit der Vorstellung (wodurch ein Gegenstand gegeben wird) auf die Beförderung der Erkenntnißvermögen in ihrem freien Spiele beurtheilen läßt; und der Geschmack als subjective Urtheilskraft enthält ein Princip der Subsumtion, aber nicht der Anschauungen unter *Begriffe*, sondern des *Vermögens* der Anschauungen oder Darstellungen (d.i. der Einbildungskraft) unter das *Vermögen* der Begriffe (d.i. den Verstand), sofern das erstere *in seiner Freiheit* zum letzteren *in seiner Gesetzmäßigkeit* zusammenstimmt." KU, AA 05: 287.

4 Concluding Remarks

I argued in the first section of this essay that the necessity involved in empirical causal laws of nature, for Kant, is the material necessity articulated in the Postulates of Empirical Thought. This kind of necessity, I argued, is perfectly illustrated by Kant's conception of the Newtonian law of universal gravitation, as discussed in both the *Prolegomena* and the *Metaphysical Foundations of Natural Science*. And the law of gravitation is thereby constitutively grounded in the categories and principles of the understanding. I then argued, in the second section, that the same kind of constitutive necessity is at issue in § 26 of the second edition Deduction, although at a much more general level of abstraction where our pure intuitions of space and time are originally unified by pure apperception. Here the transcendental synthesis of the imagination connects the understanding in general with sensibility in general by the fundamental act of continuous motion exercised in the drawing or delineation of any form of spatio-temporal unity whatsoever, and the unity of this act is therefore prior to the unity of any particular concept – whether mathematical, categorial, or empirical.

In the third section, finally, I turned to the purely regulative procedures of reflective judgement. I argued, in the first place, that these procedures still aim at the constitutive necessity expressed most fully in pure natural science – which, in particular, involves a mathematically exact realization of the pure categories and principles of the understanding. By the argument of the second section, moreover, it follows that such a realization of the understanding is also at issue in the second edition Deduction, where the transcendental synthesis of the imagination connects the understanding *in general* with sensibility *in general*. From the point of view of reflective judgement, therefore, this synthesis is also sufficiently general, at least in principle, to generate schemata – potential forms of spatio-temporal unity – adequate to any empirical concept that the infinite manifoldness of empirically given nature may require. However, whereas the transcendental synthesis of the imagination is intended to guarantee the application of geometry, the categories, and the mathematical doctrine of motion to empirically given nature, no such guarantee is possible for the faculty of reflective judgement. We have only the well-founded hope that our attempts further to progress in our comprehension of nature by ascending from sensible particulars to ever more general empirical concepts and laws may, at least in principle, continuously progress towards the fully determinate mathematical realization of the categories that Kant takes to be paradigmatically represented by pure natural science. It is in precisely this sense, I suggest, that reflective judgement – as opposed to determinative judgement – is regulative rather than constitutive.