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Michela Massimi

# Prescribing laws to nature. Part I. Newton, the pre-Critical Kant, and three problems about the lawfulness of nature

**Abstract:** This paper traces the early reflections of the pre-Critical Kant on laws of nature back to Newton's governing conception of laws. Three problems with the Newtonian conception are identified. I argue that in the attempt to provide a solution to them, in 1763 Kant came to forge a novel governing conception of laws. Key to Kant's novel view are the notions of ground and its determinations. The role of these two notions in delivering the nomological necessity, explanatory power, and unity of the laws of nature is discussed and analysed.

**Keywords:** laws of nature, governing conception of laws, Newton, pre-Critical Kant

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## 1 Introduction

What makes nature a lawful system? Kant's view about the lawfulness of nature is famously captured by some passages of the *Prolegomena* (Prol, AA 04: 320) and the second edition of the *Critique of Pure Reason* (KrV, B 165), where Kant suggests that the lawfulness of nature is the product of our faculties, primarily, the faculty of the understanding prescribing laws to nature. How did Kant arrive at this view? Did Kant subscribe to a governing conception of laws? And how should such a governing conception of laws be characterized?

In this paper, I tackle these central questions by elucidating three main points. First, I clarify what is at stake in a governing conception of laws. Second, I get clear about the historical background against which Kant came to elaborate his pre-Critical governing conception of laws, back to Isaac Newton. Third, I focus on how the pre-Critical Kant articulated his view about the lawfulness of nature in *The Only Possible Argument in Support of the Demonstration of the Existence of God* (1763), which is one of the earliest texts where Kant put forward seminal ideas about the lawfulness of nature. In Section 2, I briefly review Newton's take on the lawfulness of nature and I identify three problems left open by Newton's view. In

Section 3, I argue that Kant's view in *The Only Possible Argument* provides solutions to these three problems, which ultimately commit the young Kant to a governing conception of laws of dispositional essentialist flavor.

So what is the governing conception of laws? In contemporary terms, the governing conception takes its cue from the anti-Humean intuition that there is something special about laws of nature – they are not just descriptions of occurrent states of affairs. Key to the governing conception is the intuition that laws have a prescriptive role, or a distinctive nomological force. Laws prescribe or govern the way nature *ought* to be. The analogy is with jurisprudence, where laws are prescriptive and codify acceptable norms of social behavior, rather than being mere descriptions of factual matters about social arrangements. In jurisprudence, the prescriptive force of the laws emanates from some recognized authority that exercises its ruling power, and breaking the laws involves sanctions and punishment.

But how do laws govern nature? There seem to be three key ideas involved in the governing conception of laws. First, if laws govern, there must be a lawgiver, who imposes them. Although Humeans may rightly retort that it is not a conceptual truth that laws presuppose a lawgiver,<sup>1</sup> it is certainly such under the governing conception of laws; and for good historical reasons too, as we will see shortly. Second, laws seem to govern by prescribing, rather than describing, the way nature *ought* to behave. Finally, laws prescribe by *necessitating* states of affairs in nature. This third aspect is paramount to any governing conception of laws. What is distinctive of laws, under the governing account, is their ability to necessitate the way things ought to be. The necessity distinctive of laws takes the name of *nomological necessity*, and is usually regarded as accomplishing two distinct jobs.

Nomological necessity is primarily meant to track some *physical necessity* in nature. Laws of nature govern by capturing physical necessities in nature. For example, one may say that Coulomb's law governs electrostatic phenomena by capturing a physically necessary behavior of static electric charges. How to understand the relation between the governing role of laws and the physically necessary states of affairs varies from one strand to another of the view. For example, the standard Necessitarian view associated in contemporary philosophy of science with the names of Armstrong, Dretske, and Tooley sees physical necessity in nature as a top-down instantiation of laws of nature understood as necessitation relations between universals properties. It is *physically necessary that Fa is Ga* is an instantiation of the law that says that the universal property

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<sup>1</sup> See Beebe, Helen: "The Non-Governing Conception of Laws of Nature". In: *Philosophy and Phenomenological Research* 61, 2000, 571–594.

F-ness *necessitates*, or brings along with it, the universal property G-ness.<sup>2</sup> Under the dispositional essentialist account, on the other hand, physical necessity comes first and is grounded in nature's capacities and natural powers, from which laws of nature are read off. Thus, a dispositional essentialist would regard the nomological necessity of Coulomb's law as *grounded* on the physical necessity with which, say, a point-like electric charge has the power to attract (or repel) another point-like electric charge of opposite (or equal) charge.<sup>3</sup> Either way, top-down or bottom-up, under the governing conception of laws nomological necessity traces physical necessity in nature.

Nomological necessity does also a second job: it would typically *explain* the occurrence of events. Laws explain why the next observed Fa is going to be Ga in virtue of the necessary connection holding between F and G. By forsaking physical necessity, Humeans seem to be saddled with the problem of explaining why the next observed point-like electric charge is likely to attract an electric charge of opposite sign.<sup>4</sup> By tracking physical necessity in nature, a governing conception of laws can easily explain why the collection of past observed occurrences of Fa, which are Ga, provide also reasons for explaining (and predicting) that the next Fb we will observe is bound to be Gb (pace Hume's problem of induction).

Contemporary discussions about the governing conception of laws show at best the far-reaching legacy of the topic Kant engaged with. But they do not begin to show that Kant shared the conceptual tools of the contemporary governing conception of laws, of course. Was there any governing conception of laws at Kant's time? What were its distinctive features? In what follows, I argue that the young, pre-Critical Kant grappled with a specific governing conception of laws, offered by Newton, and with some of its philosophical problems. In 1763 Kant gave his own solution to these problems. Kant's solution borrows a key metaphysical notion (such as the notion of ground) from Wolff to provide ultimately a bottom-up account of the necessity of the laws as grounded in nature's forces and their determinations. While the key metaphysical notion is borrowed from Wolfian metaphysics, Newton's natural philosophy provided once more the template for Kant's view.

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<sup>2</sup> See Armstrong, David: *What is a law of nature?* Cambridge 1983.

<sup>3</sup> See Bird, Alexander: *Nature's Metaphysics. Laws and Properties.* Oxford 2007, and Ellis, Brian: *Scientific Essentialism.* Cambridge 2001.

<sup>4</sup> As a clarificatory remark, this is not to say that one can explain the occurrence of an event by citing nomically necessary laws. Humeans would disagree, and this is in fact a contested issue. But what nomological necessity does, is to explain why the next F will be G, by securing the physically necessary link between F and G. In the absence of that link, Necessitarians are right in noting that Hume's problem of induction looms on the horizon.

## 2 Newton's governing conception of laws

That laws presuppose a lawgiver may well not be a conceptual truth; but it is, undoubtedly, a historical truth. The governing conception of laws emerged with the scientific revolution, and the philosophical reflections that accompanied it. And a quick look at two key figures in this trend, Descartes and Newton, soon reveals that like its contemporary version, the early modern version too shares the three aforementioned points about a lawgiver, prescribing, and necessitating, with suitable provisos. The main proviso is that by contrast with the contemporary version, there is no doubt that the early modern governing conception of laws had theistic origins in the idea of God as a lawgiver imposing an order on nature.

Take Descartes, who in the *Principles of Philosophy* declared that God created matter with motion and rest and “since He moved in several different ways the particles of matter when He created them, and since He maintains all of them in the same way and with *the same laws that He made them observe through their creation*, He incessantly conserves an equal quantity of movement in matter”.<sup>5</sup> Even more poignantly: “Please do not hesitate to assert and proclaim everywhere that it is God who has laid down these laws in nature just as a king lays down laws in his kingdom”.<sup>6</sup> Or, consider Cotes' Preface to Newton's *Principia*:

this world – so beautifully diversified in its forms and motions – could not have arisen except from the perfectly free will of God, who provides and governs all things. From this source, then, have all the laws that are called laws of nature come, in which many traces of the highest wisdom and counsel certainly appear, but no traces of necessity. Accordingly we should not seek these laws by using untrustworthy conjectures, but learn them by observing and experimenting. He who is confident that he can truly find the principles of physics and the laws of things, by relying only on the force alone of his mind, and the internal light of his reason should maintain either that the world has existed from necessity, and follows the said laws from the same necessity; or that although the order of nature was constituted by the will of God, nevertheless a creature as small and as insignificant as he is has a clear understanding of the way things should be.<sup>7</sup>

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<sup>5</sup> Descartes, René: *Principles of Philosophy*. Tr. by Blair Reynolds. New York 1988, Section 36, 6. Emphasis added.

<sup>6</sup> Descartes, René: *The Philosophical Writings of Descartes*. 3 vols. Ed. by John Cottingham and Anthony Kenny. Cambridge. 1984–1989. Vol. III, 23.

<sup>7</sup> “Cotes' Preface to the Second Edition of Newton's *Principia*.” In: Newton, Isaac: *The Principia*. Tr. by Bernard Cohen, Anne Whitman and Julia Budenz. California 1999, 397f.

Cotes suggests here that the necessity of the laws cannot follow from the necessity of the world itself, nor be accessed by the force alone of one's own mind. Instead, laws follow from the order of nature established by God himself, as the perfect Lawgiver acting with wisdom and providence towards His creation.

No wonder Newton in the *Principia* used the verb "to govern" in relation to God and the laws of nature: God governs and knows all things that are or can be done and the motions of the comets are said to be governed by the same laws that govern the motion of the planets. Newton believed also that laws of motion could be inferred (or deduced) from phenomena, by observation and experiments. In no way did Newton regard *our knowledge* of the laws of nature as itself dependent upon metaphysical or theistic assumptions. However, Newton did regard the *prescribing* force of the laws of nature as originating itself from theistic assumptions. Newton was, in fact, critical of the Cartesian idea that sheer mechanical causes could originate motions; as he was sceptical of the idea that laws of nature per se could explain what set planets and comets in motion. Instead, for Newton, the source of the lawfulness of nature had to be found in the Biblical Lord God Pantokrator. Nature, with all its mathematically demonstrable forces and laws, is ultimately the dominion of God. In the General Scholium, Newton writes: "[All bodies] will indeed persevere in their orbits by the laws of gravity, but they certainly could not originally have acquired the regular positions of the orbits by these laws. [...] This most elegant system of the sun, planets and comets could not have arisen without the design and dominion of an intelligent and powerful being. [...] He rules all things, not as the world soul but as the lord of all. And because of his dominion he is called Lord God Pantokrator".<sup>8</sup>

Laws of nature originate from the deliberations and free choice of a Universal Ruler. Newton laid the foundations for a governing conception of laws, which proved influential in the centuries to come. The necessity of the laws (e.g., the necessity through which Newton's laws prescribe orbital motions) ultimately derives from, and depends upon God. Laws prescribe nature only to the extent that God has freely established them to rule His dominion. Yet Newton's account left open three important questions, which, not surprisingly, became the battleground for philosophical disputes in the following decades:

- (1) *The problem of nomological necessity.* Laws of nature enjoy a special status because they originate directly from God's free choice and deliberations. But if their nomological necessity is, so to speak, derivative from God's free

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<sup>8</sup> Newton, Isaac: *Principia*, General Scholium, 940.

choice and deliberation, how could laws *by themselves* (i.e. without resorting to God himself) genuinely prescribe the way nature ought to be?<sup>9</sup>

- (2) *The problem of explicability.* The universality and immutability of the laws, under Newton's account, seems to capture universal and immutable *relational properties* (or proportions) among material objects. The law of gravity, for example, captures how the force of gravity is inversely proportional to the square of the distance between any two material bodies. This inverse proportion between the force  $F$  and the squared-distance  $r^2$  is invariable. But the Newtonian account does not tell us much about what one might call the intrinsic, *monadic properties* that presumably ground such relational properties, or immutable proportions in nature. No wonder, Leibniz retorted that the operations of the force of gravity were miraculous, absurd, or simply obscure.<sup>10</sup>

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**9** Another way of expressing this point is that the necessity that cascades down from the Lord God Pantokrator to nature via laws seems to be missing the metaphysical step between the necessity of the laws (coming from God's choice, directly), and the supposedly necessary connections in nature (e.g., between forces and motions), which laws are meant to capture. Laws seem to be lacking a genuine prescriptive force *in and of themselves*, in Newton's system. Newton was left with no other choice than making his God Pantokrator the Work-Day God, rather than the God of the Sabbath, to use Koyré's apt expression, with all the paradoxical consequences that Leibniz's second paper against Clarke clearly highlighted: "I do not say the material world is a machine, or watch, that goes without God's interposition [...]. But I maintain it to be a watch, that goes without wanting to be mended by him: otherwise we must say that God bethinks himself again [...]. 12. To conclude. If God is obliged to mend the course of nature from time to time, it must be done either supernaturally or naturally. If it be done supernaturally, we must have recourse to miracles, in order to explain natural things: which is reducing an hypothesis ad absurdum [...]. But if it be done naturally, then God will not be *intelligentia supramundana* [...] that is, he will be the soul of the world". In: *The Leibniz-Clarke correspondence*. Ed. by H. G. Alexander. Manchester 1956, 18 and 20.

**10** "112. In good philosophy, and sound theology, we ought to distinguish between what is explicable by the natures and powers of creatures, and what is explicable only by the powers of the infinite substance. We ought to make an infinite difference between the operation of God, which goes beyond the extent of natural powers; and *the operations of things that follow the law which God has given them, and which he has enabled them to follow by their natural powers, though not without his assistance.* 113 This overthrows attractions, properly so called, and other operations inexplicable by the natural powers of creatures; which kinds of operations, the assertors of them must suppose to be effected by miracles, or else have recourse to absurdities, that is, to the occult qualities of the schools". Leibniz's fifth paper, in *The Leibniz-Clarke correspondence*, 92, emphases added. For a recent discussion of the explanatory role of the laws in Newton, see Jansson, Lina: "Newton's 'satis est': a new explanatory role for laws". In: *Studies in History and Philosophy of Science* 44, 2013, 553–562.

- (3) *The problem of unity.* Newton famously refused to enter metaphysical discussions about the cause of gravity, and repeatedly denied that gravity was an essential or inherent<sup>11</sup> property of matter (by contrast with inertia). In so doing, he provided only a mathematical, not a metaphysical account of gravity. To the eyes of many contemporaries of Newton, a metaphysical account was needed to provide unity to what would otherwise be a contingent aggregate of phenomena subject to gravity (from ocean's tides, to the free fall, and planetary motion).

In the next Section, I argue that the young Kant grappled with these pressing questions about laws of nature and their governing role, left open by Newton and ensuing debates with Leibniz. In 1763 the young Kant gave some provisional solutions to these three problems, by trying to reconcile the role of God as the supreme Lawgiver and the ultimate source of the order of nature (along Newton's lines), with the metaphysical (Wolffian) idea of necessary connections in nature explicated in terms of grounds and their determinations.

### 3 The pre-Critical Kant in 1763: early reflections on laws of nature, and their governing role

*The only possible argument in support of a demonstration of the existence of God,* is one of the very first texts where Kant offered a philosophical analysis of laws of nature, their governing role, and necessity. By that time, Kant had already abundantly engaged with Newton's natural philosophy both in *Universal Natural History* (1755) and *Physical Monadology* (1756), alongside other short essays in natural science of this period, such as *On Fire*, a couple of texts on the rotation of

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<sup>11</sup> See Newton, Isaac, op. cit., Rule 3, 796 “Yet I am by no means affirming that gravity is essential to bodies. By inherent force I mean only the force of inertia. This is immutable. Gravity is diminished as bodies recede from the earth”. This point is even more forcefully expressed in Newton's correspondence with Bentley: “You [Bentley] sometimes speak of Gravity as essential and inherent to Matter. Pray do not ascribe that Notion to me”. In: Newton, Isaac: *Correspondence*. Ed. by H. W. Turnbull, A. Rupert Hall and L. Tilling. Cambridge 1959–1977, vol. III, 240. For recent discussion on gravity as an active yet inessential power of matter superadded by God, please see Henry, John: “Gravity and *De Gravitatione*: the development of Newton's ideas on action at a distance”. In: *Studies in History and Philosophy of Science* 42, 2011, 11–27. For a discussion of how Newton rejected gravity as an essential inherent property of matter to avoid the charge of Epicureanism, see Ducheyne, Steffen: “Newton on action at a distance and the cause of gravity”. In: *Studies in History and Philosophy of Science* 42, 2011, 154–159.



the Earth and the age of the Earth (1754), three short notes on earthquakes (1756), a theory of the winds (1756), and most famously *New doctrine of motion and rest* (1758). While familiar with Newton's natural philosophy and its fundamental principles of repulsion and attraction, before 1763 Kant had not engaged directly with the Newtonian governing conception of laws. In the 1763 essay, *Third Reflection*, Kant tackled the issue of how things in the world depend on God via the order of nature that He has established:

Something is subsumed under the order of nature if its existence or its alteration is sufficiently *grounded* in the forces of nature. The first requirement for this is that the force of nature should be the efficient cause of the thing; the second requirement is that the manner in which the force of nature is directed to the production of this effect should itself be sufficiently grounded in a rule of the natural laws of causality. Such events are also called, quite simply, *natural* events of the world.<sup>12</sup>

Thus, natural events are those whose efficient causes are *forces of nature*, which in turn produce their effects according to the “natural laws of causality”. Kant phrases the whole passage in terms of events being “sufficiently grounded” in forces, and the force-effect relation itself being “sufficiently grounded” in the laws of causality. This terminology is carefully chosen, and betrays a subtle point that is key to my analysis. Kant introduces forces of nature and the laws of causality to distinguish natural events from *supernatural ones*, whereby either their cause is not grounded in forces of nature, or the force-effect relation is not grounded in a rule of nature itself. This distinction between natural and supernatural events is functional to show how events such as earthquakes, hurricanes, tempests, which had occasionally been invoked as God's punishment on the vicious deeds of a particular town or population, should in fact be regarded as misfortune, Kant claims, because “man's conduct cannot be a cause of earthquakes according to a natural law, for there is no connection here between the cause and the effect”.<sup>13</sup> However, Kant soon rectifies

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**12** “Es steht etwas unter der Ordnung der Natur, in so fern sein Dasein oder seine Veränderung in den Kräften der Natur zureichend gegründet ist. Hierzu wird erfordert erstlich, daß die Kraft der Natur davon die wirkende Ursache sei; zweitens, daß die Art, wie sie auf die Hervorbringung dieser Wirkung gerichtet ist, selbst in einer Regel der natürlichen Wirkungsgesetze hinreichend gegründet sei. Dergleichen Begebenheiten heißen auch schlechthin natürliche Weltbegebenheiten.” BDG, AA 02: 103.

**13** “[...] das [...] Verhalten der Menschen kein Grund der Erdbeben nach einem natürlichen Gesetze sein kann, weil hier keine Verknüpfung von Ursachen und Wirkungen statt finde.” BDG, AA 02: 104.

if the earthquake is to be regarded as a punishment, then it follows that, since these forces of nature cannot, according to any natural law, have any connection with the conduct of man, they must in each individual case be especially instituted by the Supreme Being. And then the event is supernatural in the formal sense of the word, even though the intermediate cause of the event was a force of nature. (ibid.)<sup>14</sup>

Starting with the Newtonian template of God as the supreme Lawgiver (while also obviously engaging with Leibnizian theodicy), Kant teases out three distinct notions in this passage:

- i. the order of nature includes *natural* events only;
- ii. natural events are events *grounded* in forces of nature qua causes and *obey* the natural laws of causality in the force-effect production;
- iii. God could *ad hoc* institute forces of nature to produce devastating effects such as earthquakes as a punishment for humankind's moral conducts, but this would be a *supernatural* event (via natural causes), because it would violate universal natural laws.

I am not going to press here Kant's point against Leibniz's theodicy, because my goal is to understand how Kant envisaged instead the order of nature according to the natural law of causality. Despite God having created the whole arrangement of natural events in the world, and despite Him being able to intervene supernaturally in the world as needed, the order of nature seems to enjoy a certain de-

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<sup>14</sup> "Soll es dagegen als eine Strafe betrachtet werden, so müssen diese Kräfte der Natur, da sie nach einem natürlichen Gesetze den Zusammenhang mit der Führung der Menschen nicht haben können, auf jeden solchen einzelnen Fall durch das höchste Wesen besonders gerichtet sein; alsdann aber ist die Begebenheit im formalen Verstande übernatürlich, obgleich die Mittelsache eine Kraft der Natur war." BDG, AA 02: 104f. It is worth noting here Kant's distance from Leibniz: "89. It can also be said that God as architect satisfies in every way God as legislator, and that *sins must therefore carry their punishment with them by the order of nature*, and by virtue of the mechanical structure of things itself [...]." *Monadology*. Ed. by Lloyd Strickland. Oxford. Forthcoming. Emphases added). For Leibniz, earthquakes and any other similar natural events function as punishment for human sins according to an order of nature, not because human sins may act as efficient causes for these natural events, but rather because of the pre-established harmony between the order of nature and the order of grace. Or better, between the "physical kingdom of nature", where God is the "architect of the machine of the universe", and the "moral kingdom of grace", where God is the "monarch of the divine city of minds" (*Monadology* 87). But Kant, who as early as in *New Elucidation* had criticized Leibniz's pre-established harmony, could not avail himself of Leibniz's explanation here. Earthquakes, tempests, when acting as punishment for humankind's sins, are *supernatural* according to Kant, in that they do not follow the order of nature (either in the material or in the formal sense).

gree of metaphysical autonomy. Laws of nature, especially the “natural laws of causality”, govern nature by fixing the ways in which forces and their effects, qua *grounds* and *determinations*, are related. Any intervention on behalf of God on this order of natural events, whilst possible, would be *supernatural*, subject to the “immediate divine law, that of the wisdom of God”, but in violation of any natural law. Nature with its lawful unity is not downstream of the supreme Lawgiver, as it becomes even more clear in Kant’s discussion of the necessity that accrues to the order of nature:

All natural things are contingent in their existence. [...] But although the laws of nature, like the things themselves of which they are the laws, accordingly appear to have no necessity, and although, again, the connections in which these laws can be exercised are contingent, there nonetheless remains a kind of necessity which is very remarkable. There are, namely, many laws of nature, of which the unity is necessary.<sup>15</sup>

What is this necessity that accrues to laws of nature taken as a whole? How can necessity be bestowed on contingent natural events, whose lawful connections are themselves said to be contingent? In my view, Kant’s answer to this question relies on the key concept of *ground*. As Eric Watkins has extensively documented,<sup>16</sup> Kant’s discussion about grounds and determinations began in *Nova dilucidatio* (1755), where in the context of his discussion of the two new principles of co-existence and succession, Kant identified the essence of a thing with its necessary ground, and grappled with the difficult question of explaining how essential, and hence immutable grounds can possibly explain how a substance may change over time. Kant was latching onto the well-established tradition of Wolff and Baumgarten about *logical grounds* as necessary grounds responsible for the possible essential determinations of things. Kant introduced a distinction between logical ground, and real ground, which became key to understanding the necessary connections between substances. In what follows, I take Watkins’s analysis of the pre-Critical Kant on real grounds on board. I elucidate how in *The only possible argument* Kant could give his own solution to the problem of nomological necessity, once the direct link with the Newtonian Lord God Pankrator had been severed.

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<sup>15</sup> “Alle Dinge der Natur sind zufällig in ihrem Dasein. Allein obgleich die Naturgesetze in so fern keine Nothwendigkeit zu haben scheinen, als die Dinge selbst, davon sie es sind, imgleichen die Verknüpfungen, darin sie ausgeübt werden können, zufällig sind, so bleibt gleichwohl eine Art der Nothwendigkeit übrig, die sehr merkwürdig ist. Es giebt nämlich viele Naturgesetze, deren Einheit nothwendig ist [...]” BDG, AA 02: 106.

<sup>16</sup> E. Watkins (2005) *Kant and the Metaphysics of Causality*, Cambridge University Press, ch. 2.

How can the notion of real ground help us answer the above questions about the necessary unity of the laws? Kant gives the example of “the self-same elasticity and pressure of the air” [*dieselbe elastische Kraft und Schwere der Luft*] as the ground of “the laws of respiration” [*Gesetz[.] des Athemholens*] but also

of necessity the ground of the possibility of pumps, of the generation of clouds, of the maintenance of fire, of the winds, and so on. It is necessary that, as soon as the *ground* of even merely one of them be present, the *ground* of the others should also be present.<sup>17</sup>

In other words, as soon as we posit the elasticity (or repulsive force) of the air as a real ground, *necessarily* the generation of the clouds, the maintenance of fire, of the winds, so forth obtain as effects.

These examples are not surprising. As early as in *True estimation*, Kant had identified elasticity or elastic force as the “true machine of nature” [*wahre Maschine der Natur*],<sup>18</sup> which can be released and triggered by elastic impact of bodies, following a view which he thereby attributed to the Cartesian Jean-Jacques Dortus De Mairan in his polemic exchange with Emile Du Châtelet about *vis viva*.<sup>19</sup> In *Universal Natural History*, Kant took the key step of associating elasticity with Newton’s repulsive force, whereby elasticity or better “elastic air” [*elastische[.] Luft*] was presented as “capable of maintaining the most violent degrees of fire” [*vermögend [...] die heftigsten Grade des Feuers [...] zu unterhalten*]<sup>20</sup> in the atmosphere of the Sun; and in his 1756 *Theory of the Winds* the cause of the winds was itself identified in the “decrease of the expansive force by cold and vapours that reduce the elasticity of the air” [*Verminderung der ausspannenden Kraft durch Kälte und Dämpfe, die die Federkraft der Luft schwächen*].<sup>21</sup> Back to the 1763 essay, Kant concludes that

If the ground of the effects of a certain kind, which are similar, according to one law is not at the same time, the ground of effects of a different kind in the same being, according to another law, then the agreement of these laws with each other is contingent,<sup>22</sup>

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<sup>17</sup> “[...] nothwendiger Weise zugleich ein Grund von der Möglichkeit der Pumpwerke, von der Möglichkeit der zu erzeugenden Wolken, der Unterhaltung des Feuers, der Winde etc. Es ist nothwendig, daß zu den übrigen der *Grund* anzutreffen sei, so bald auch nur zu einem einzigen derselben *Grund* da ist.” BDG, AA 02: 106. Emphasis added.

<sup>18</sup> GSK, AA 01: 55.9.

<sup>19</sup> For details, please see Massimi, Michela and De Bianchi, Silvia: “Cartesian echoes in Kant’s philosophy of nature”. In: *Studies in History and Philosophy of Science* 44, 2013, 481–492.

<sup>20</sup> NTH, AA 01: 325.19.

<sup>21</sup> TW, AA 01: 491.

<sup>22</sup> “Dagegen wenn der Grund einer gewissen Art ähnlicher Wirkungen nach einem Gesetze nicht zugleich der Grund einer andern Art Wirkungen nach einem andern Gesetze in demselben

and contingent the unity of these laws. In other words, if the ground of one set of effects as given by a law (say the law that explains how the decrease in the elasticity causes alteration in the equilibrium of the atmosphere, which results in winds being produced) were not also the ground for a different kind of effects in the same entity, according to another law (say, the law of combustion, which explains how fire can be maintained by elastic air), then the unity of these two laws would be merely contingent, and contingent would be the order of nature established by these laws.

The same line of reasoning applies to gravity, which in *Universal Natural History* Kant had already identified as one of the two key forces responsible for the constitution of the universe. In *The Only Possible Argument* Kant identifies gravity as “a cause which is, of necessity, sufficient to produce all these effects” (e.g. give the earth its spherical form, keeps the moon in its orbit, etc.). Kant’s conclusion is unequivocal:

Now, the fact that grounds are to be found in nature for all these effects is, without doubt, a perfection. And if the same ground which determines the one thing should also be sufficient to determine the others, then the unity which accrues to the whole is so much the greater. But this unity and, along with it, the perfection as well, are, in the present case, necessary, and they attach to the *essence of the thing*. And all the harmoniousness, fruitfulness, and beauty, which are in so far due to that unity, depend upon God either through the mediation of the essential order of nature, or through the mediation of that which is necessary in the order of nature.<sup>23</sup>

How can nature constitute a lawful unity, despite the contingency of natural events? The Newtonian governing conception of laws left Kant with the three philosophical problems we saw above, but it also provided the key to answering them via the specific examples of elasticity and gravity as two fundamental forces of nature.

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Wesen ist, so ist die Vereinbarung dieser Gesetze zufällig, oder es herrscht in diesen Gesetzen zufällige Einheit, und was sich darnach in dem Dinge zuträgt, geschieht nach einer zufälligen Naturordnung.” BDG, AA 02: 106.

**23** “Nun ist es ohne Zweifel eine Vollkommenheit, daß zu allen diesen Wirkungen Gründe in der Natur angetroffen werden, und wenn der nämliche Grund, der die eine bestimmt, auch zu den andern hinreichend ist, um desto mehr Einheit wächst dadurch dem Ganzen zu. Diese Einheit aber und mit ihr die Vollkommenheit ist in dem hier angeführten Falle nothwendig und klebt dem *Wesen der Sache* an, und alle Wohlgerheimtheit, Fruchtbarkeit und Schönheit, die ihr in so fern zu verdanken ist, hängt von Gott vermittelt der wesentlichen Ordnung der Natur ab, oder vermittelt desjenigen, was in der Ordnung der Natur nothwendig ist.” BDG, AA 02: 107. Emphasis added.

Recall the *problem of nomological necessity*: i.e., the necessity of the laws, downstream of God as the supreme Lawgiver, did not seem to have a lien on nature, without the back-up and intervention of God himself. But Kant could not accept this Newtonian picture for two main reasons, I suggest. First, it delegates the nomological necessity of, say, the law of gravity to God's free choice, without really being able to explain *why* Fs are Gs, why the Moon, Jupiter, or any planet persevere in their orbits; or why the Earth is spherical; and so on. Is it gravity that *necessitates* these effects? How should we think of gravity as a force of nature, for it to *govern* these effects? The Newtonian view makes nomological necessity parasitic upon God's legislative choice *and interventions in nature*. As such, not only does it deprive gravity (*in and of itself*) of its prescriptive, nomological force. It also makes the effects due to gravity somehow inexplicable in the light of *the law of gravity itself*.

Here we come to the second aforementioned problem arising from Newton's view, the *problem of explicability*. We are reminded here of Leibniz's warning of not to confuse the operations of God, with the "operations of things that follow the law that God has given them, and which *he has enabled them to follow by their natural powers*, though not without his assistance".<sup>24</sup> To avoid Leibniz's charge that the operations of the force of gravity were miraculous and obscure, the young Kant felt the need of clarifying this crucial point. God might have given laws to nature. But for those laws to have prescriptive force *as well as* for them to be able to explain their effects, laws must track the way in which *natural powers* act. God has bestowed natural powers on things in nature, and has also fixed the laws by which natural powers should abide. The young Kant seems to be responding to Leibniz (on behalf of Newton) that the operations of natural powers do not require God's intervention, although it is God, who has ultimately implanted these natural powers – qua *real grounds* – in nature, and has also given them laws to follow. In this way, Kant gave his own solution to both the problem of nomological necessity and the problem of explicability. His solution consists in populating nature with real grounds for the determination of a plurality of effects via natural laws. The nomological necessity of the laws tracks then the way in which if ground *x* is posited, *necessarily* effect *y* follows.

Kant's solution to the problems left open by the Newtonian picture was to shift the burden of nomological necessity from God's legislative choice to nature itself, by empowering nature with grounds (intended as *real grounds*) for the determinations of various effects. Once more, Newton's natural philosophy provided Kant with the examples he needed. The necessity with which objects con-

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<sup>24</sup> See footnote 10 above. Emphasis added.

form to the law of gravity is no longer downstream of God's legislative choice, but resides instead in the ground-effect modal relation, whereby the same ground may be causally responsible for a plurality of effects (e.g. making the Earth spherical, lumping fine matter into planets and stars, keeping planets and comets in their orbits, and so on). Similarly, the elasticity of the air acts as a ground for a variety of effects in nature, from the generation of clouds, to the maintenance of fire, and human respiration. These two fundamental forces of nature act as grounds *sufficient* to determine a variety of effects. They act as *real* grounds, which attach to the *essence of things* and determine their effects (e.g. being elastic is for Kant a ground that belongs to the essence of air – qua “elastic air” – and brings along with it many different effects).

Kant's threefold solution to the problems left open by Newton's governing conception of laws can then be summarized as follows.

(1.a) *Nomological necessity*. Laws govern nature by necessitating the way in which natural powers act. God might well have given laws to nature as His dominion. But laws of nature have prescriptive force by fixing the bounds within which nature's powers unfold and manifest themselves. Thus, for example, the law of gravity, while coming from God, it has a prescriptive force *in and of itself*, by fixing the bounds within which gravity as a natural power – or, as Kant calls it, as a *ground* – acts: namely, by being inversely proportional to the square of the distance, but directly proportional to the masses of the bodies. In sum, *laws govern by necessitating the universal and immutable relations, under which natural powers or real grounds operate* (e.g.  $r^2$ ).

(2.a) *Explicability*. The notion of *ground* involves modality, and can be characterized in terms of necessity. For example, the maintenance of fire is *grounded* in the repulsive force as a *real ground*, as much as the spherical form of the Earth is *grounded* in the attractive force as another *real ground*. Being grounded here means the following:

- I. if the attractive force obtains, then, *necessarily*, the spherical form of the Earth obtains too.
- II. if the repulsive force obtains, then, *necessarily*, the maintenance of the fire obtains too.

How to understand the modal nature of grounding here may vary, but I want to suggest that the young Kant was suggesting a *causal* reading: the maintenance of fire is grounded in the repulsive force in the sense that it obtains *because* of the repulsive force. Similarly, the spherical form of the Earth is grounded in the at-

tractive force in the sense that it obtains *because of it*. No wonder Kant calls grounds “causes”, and phenomena such as fire, winds, clouds “effects”. Understanding the ground-effect modal relation in causal terms allowed Kant to *explain* the operations of Newton’s two central forces, attraction and repulsion. Pace Leibniz, the operation of natural powers, such as attraction and repulsion, are neither miraculous nor obscure. By making attraction and repulsion *grounds*, and by interpreting the ground-effect modal relation in causal terms, Kant was rescuing Newton from Leibniz’s objection of having introduced occult, inexplicable qualities in natural philosophy.

At this point, the careful reader may worry that Kant’s solution to the problem of explicability has only the effect of landing Kant into the treacherous terrain of Godless Epicureanism, which Newton was himself at pain to avoid by denying that gravity was an *essential property of matter*. And yet, the worry can soon be deflated by noting how not only did Kant expressly distance himself from the “blind necessity” of Epicureanism.<sup>25</sup> He also regarded the essential order of nature – constituted by forces of nature qua grounds, *and* by the natural law of causality at work in the modal relation between grounds and effects – as subsumed under God as the ultimate ground.<sup>26</sup> No charge of lingering atheism could be legitimately leveled against Kant’s solution.

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<sup>25</sup> See BDG, AA 02: 123.

<sup>26</sup> BDG, AA 02: 99. “And the necessity of these laws is such that they can be derived from the universal and essential constitution of all matter without the least experiment and with the greatness distinctness. This acute and learned man [Maupertuis] immediately senses that in having thus introduced unity [via the principle of least action, MM] into the infinite manifold of the universe and created order in what was blindly necessary, there must be some single supreme principle to which the totality of things owed its harmony and appropriateness. He rightly believed that such a universal cohesiveness [...] afforded a far more fitting foundation for the indubitable discovery, in some perfect and original being, of the ultimate cause of everything in the world”. [Gleichwohl sind die Gesetze der Bewegung selber so bewandt, daß sich nimmermehr eine Materie ohne sie denken läßt, und sie sind so nothwendig, daß sie auch ohne die mindeste Versuche aus der allgemeinen und wesentlichen Beschaffenheit aller Materie mit größter Deutlichkeit können hergeleitet werden. Der gedachte scharfsinnige Gelehrte empfand alsbald, daß, indem dadurch in dem unendlichen Mannigfaltigen des Universum Einheit und in dem blindlings Nothwendigen Ordnung verursacht wird, irgend ein oberstes Principium sein müsse, wovon alles dieses seine Harmonie und Anständigkeit her haben kann. Er glaubte mit Recht, daß ein so allgemeiner Zusammenhang in den einfachsten Naturen der Dinge einen weit tauglichern Grund an die Hand gebe, irgend in einem vollkommenen Urwesen die letzte Ursache von allem in der Welt mit Gewißheit anzutreffen, als alle Wahrnehmung verschiedener zufälligen und veränderlichen Anordnung nach besondern Gesetzen.] In this sense, Kant can also defend what, a few lines later, he calls the “contingency of the laws of motion in the real sense of the term” (“Zufälligkeit der Bewegungsgesetze im Realverstande”; BDG, AA 02: 100): namely, “the laws of motion and



(3.a) *Unity*. Newton's mathematical treatment of gravity left wide open the issue of what confers unity to the *contingent* aggregate of phenomena including free fall, ocean's tides, planetary motions and so on. A metaphysical, rather than mathematical, treatment was needed to this effect. But Newton never offered one, as Kant complained as early as 1847.<sup>27</sup> By introducing a one-to-many ground-effects modal relation between gravity and all the aforementioned phenomena (or, between the repulsive force and the wide-ranging phenomena of the formation of winds and clouds, respiration, and fire), Kant could defend the unity, and hence the harmoniousness, fruitfulness, and beauty of the order of nature:

The forces of nature and the causal laws which govern them, contain the ground of an order of nature. This order of nature, in so far as it embraces a complex harmony in a necessary unity, has the effect of turning the combination of much perfection in *one* ground into a law. Thus, different natural effects are, in respect of their beauty and usefulness, to be regarded as subsumed under the essential order of nature, and, by that means, as subsumed under God.<sup>28</sup>

Against Newton's top-down governing conception of laws, the young Kant advanced a bottom-up governing conception of laws, whereby the essential order of nature with its fundamental forces as *grounds* comes first, and laws of nature govern by tracking the modal, one-to-many, relation between grounds and their effects. The prescriptive force of the laws originates then from the necessary unity of the order of nature so understood, as an order of natural events where forces act as grounds for the modal determination of their effects under the "natural law of causality". While subsumed under God, and depending ultimately on God (qua

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the universal properties of matter, subject to these laws, must depend on some one great common original being, which is the ground of order and harmoniousness" [die Bewegungsgesetze und die allgemeine Eigenschaften der Materie, die ihnen gehorchen, [müssen] irgend von einem großen gemeinschaftlichen Urwesen, dem Grunde der Ordnung und Wohlgereimtheit, abhängen]. It is perfectly compatible with Kant's governing conception of laws to assume that while laws are necessary in capturing ground-effects modal relations in nature, they are also ultimately contingent in depending on God, as Himself the ultimate ground of the order of nature. The Newtonian intuition is rescued (laws are expression of a diving Lawgiver), but their prescriptive force and explanatory power has now been fully explicated and defended.

<sup>27</sup> See GSK, AA 01: 62.12–15.

<sup>28</sup> "Weil nun die Kräfte der Natur und ihre Wirkungsgesetze den Grund einer Ordnung der Natur enthalten, welche, in so fern sie mannigfaltige Harmonie in einer nothwendigen Einheit zusammenfaßt, veranlaßt, daß die Verknüpfung vieler Vollkommenheit in einem Grunde zum Gesetze wird, so hat man verschiedene Naturwirkungen in Ansehung ihrer Schönheit und Nützlichkeith unter der wesentlichen Naturordnung und vermittelst derselben unter Gott zu betrachten." BDG, AA 02: 107f.

ultimate ground) for its contingent existence, the order of nature enjoys also a certain degree of metaphysical autonomy from God in its operations. Kant's God is no longer Newton's Lord God Pantokrator, governing His dominion with His immediate hand. In its place, Kant put the essential order of nature, as mediating between the array of contingent natural events and God himself as the ultimate ground.

## Concluding remarks

In this essay, I have taken some steps towards reconstructing the evolution of Kant's view on the lawfulness of nature in the pre-Critical period. I have shown what is philosophically at stake in a governing conception of laws (namely, nomological necessity and explanatory power). I have taken Newton as an illuminating example of the governing conception of laws in the early modern period, and I have illustrated some of the problems affecting Newton's view. Finally, I have argued that the young Kant around 1763 came to elaborate his own governing conception of laws, drawing on Newton's natural philosophy for making his case, while also providing his own solutions to the problems left open by Newton. The final result is a governing conception of laws that retrieves the explanatory power, nomological necessity, and the unity of the laws via the key metaphysical notion of ground and the modal relation between grounds and effects.

Kant could retrieve the explanatory power of the laws (e.g. why fine matter lumps; why planets stay in their orbits; why fire burns in the bowels of the Sun; and so on) by making attraction and repulsion *grounds* that belong to the essence of matter and air, respectively; and, by interpreting in causal terms the modal relation between grounds and their effects (i.e. repulsion or elastic force obtains in the air; and, *necessarily*, if repulsion obtains, fire is generated and maintained in the bowels of the Sun where elastic air is trapped). Laws are explanatory because they track necessary ground-effects connections in nature, and in so doing they also bring nature – as a sum of contingent natural events – into a unity, which is perfect and necessary.

Kant could also retrieve the nomological necessity of the laws, not as downstream of God's legislative choice, but as “the necessary unity in the relation between a simple ground and a multiplicity of appropriate consequences” [*einer nothwendigen Einheit in der Beziehung eines einfachen Grundes auf viele anständige Folgen*].<sup>29</sup> Laws of nature govern by positing simple grounds, whose “essen-

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<sup>29</sup> BDG, AA 02: 107.

tial fruitfulness” brings along with it or *necessitates* a plurality of effects. Thus, the young Kant could defend a *bona fide* governing conception of laws, by building nomological necessity bottom-up, from nature’s grounds and their necessary effects. This is a hefty metaphysical price to pay, as Kant came to realize eventually. No wonder, in the Critical period, Kant came to distinguish between the “lawfulness of things in themselves” [*Gesetzmäßigkeit [von] Dingen an sich selbst*] and the “necessary lawfulness” [*nothwendige [...] Gesetzmäßigkeit*] of the appearances (qua *natura formaliter spectata*),<sup>30</sup> which the faculty of the understanding prescribes. By making causal laws prescriptions of the faculty of the understanding on appearances, Kant arrived at a mature governing conception of laws. The kind of necessity afforded by Kant’s mature view is, in the end, a purely transcendental one, not a metaphysical one as any governing conception of laws would require. But this is a story for another paper.

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<sup>30</sup> KrV, B 164–165.