Introduction

Over the years laws of nature have received much attention in philosophy of science, and Kant's philosophy of natural science has become a flourishing area of research. This collection is the first to map the ground of Kant's mature view on the laws of nature. We ask what a law of nature is for Kant; how, on his account, we come to know laws of nature; what necessity laws exhibit; and how laws in the physical sciences might differ from those in the biological sciences. The thirteen chapters collected here shed light on different facets of Kant's account and highlight the centrality of the topic for Kant. As the chapters show, Kant's conception of the laws of nature is continuous with key themes in his metaphysics and epistemology and a core component of his philosophical system.

Kant scholarship has traditionally stressed the differences between Kant's view on laws in physics and biology. The former, expounded most famously in the *Metaphysical Foundations of Natural Science*, find their underpinning in constitutive a priori principles and figure in the mechanical explanations typical of the physical sciences. The latter, famously discussed in the *Critique of Judgment*, find their expression in regulative principles, which guide the teleological considerations afforded by the life sciences. The emphasis traditionally placed on this constitutive–regulative dichotomy – while instructive – has had the effect of obscuring a more profound truth about Kant's view on the laws of nature. For Kant's reflections on this topic are not simply downstream to philosophical discussions about the constitutive principles of the faculty of understanding and the regulative principles of the faculties of reason and reflective judgment. Instead, Kant's reflections on the laws of nature originate from and are informed by his life-long engagement with the sciences of his time. Kant's mature view on the constitutive principles of the understanding and the regulative principles of reason is thus rather the final outcome of his life-long, systematic inquiry into the lawfulness of nature. Moreover, the underlying themes, conceptual commonalities, and metaphysical ideas

clearly reveal the continuity Kant saw between the lawfulness of phenomena in the physical and in the life sciences.

Kant was acutely aware that we live in a world that, from the mineral to the animal kingdom, follows regular patterns and manifests lawlike behavior. What then is, for Kant, a law of nature? And in what way do laws govern nature? The first three chapters in Part I set the record straight on these two central questions. In Chapter 1, Eric Watkins charts the territory of the various kinds of law Kant advocates throughout his writings. They include empirical laws of nature; the logical laws of homogeneity, specification, and continuity; and four a priori laws of cosmology, to mention only a few salient examples. This variety notwithstanding, Watkins argues that Kant held a coherent and unified view of what a law of nature is. On Watkins's reading, to be a law means to be necessary, and to be so in virtue of a spontaneous legislative act. On the one hand, Watkins's interpretation stresses the continuity between Kant's mature view in the *Critique of Pure Reason*, where the faculty of understanding is said to "prescribe" laws to nature, and Kant's conception of the moral law in his practical philosophy. On the other hand, Watkins argues that the difference among kinds of laws can be explained by the different cognitive faculties that legislate them, different acts, and ultimately different kinds of necessity.

In Chapter 2, Karl Ameriks probes Watkins's interpretation further, with an eye to underlining the continuity of Kant's theoretical and practical philosophy. On Ameriks's reading of Kant, the necessity of the laws originates from the way in which the antecedent of a lawlike statement acts as a determining ground for the consequent. The determining ground can here be understood as either causal (in natural science) or normative (in morality). By laying out a sophisticated taxonomy with seven main distinctions concerning necessity (and universality) in Kant, Ameriks reminds us of the absolute centrality that the topic of lawfulness plays in Kant, and of its pivotal role to modality, mathematics, and morality.

How we come to know particular causal laws on Kant's account is Paul Guyer's topic in Chapter 3. Hume had brought attention to the limits of what can be known by induction. But Kant's worry about the incompleteness of our knowledge of the laws of nature is not motivated by the same Humean skeptical doubts, according to Guyer. For Kant, we come to know particular causal laws through the workings of the faculty of reflective judgment, in its attempt to fulfill the requirements of systematicity laid out by reason. Our knowledge of particular laws thus depends on our coming to know nature as a *system of laws*, with lower level laws being

subsumed under higher level (yet still empirical) laws. On Guyer's reading, it is the systematic unity of the classificatory and explanatory concepts at play in particular causal laws, which ultimately explains why the law-governed behavior of any object is part of a wider law-governed behavior of an entire class of properties (patterns of motion due to gravity, for example). Systematicity plays then an important role for Kant in making us encounter nature as lawful.

Part II of the volume zooms in on the idea of the systematicity of nature and its central role in Kant's account of laws. In Chapter 4, Hannah Ginsborg focuses on the question of why, on Kant's account, we must presuppose the systematicity of nature. She maintains that the principle of systematicity is required not only for pursuing scientific inquiry, but also, and more fundamentally, for arriving at empirical concepts and laws in the first place. Ginsborg argues for this claim by showing that the principle of systematicity is a consequence of the more basic presupposition that nature is purposive for our cognitive faculties. She suggests that we understand this presupposition of nature's purposiveness not as a factual claim about nature, but rather as a claim about the normative fit between nature and our judging of it. On her account, the principle of purposiveness asks us to regard the natural phenomena we seek to understand as being such that our cognitive activity is appropriate to them. The presupposition of the purposiveness of nature is, on this reading, a condition of the exercise of judgment. Furthermore, it commits us to the presupposition that nature is systematic.

In Chapter 5, Rachel Zuckert examines the function Kant attributes to the ideas of reason – the ideas of the soul, the world as a whole, and God – in guiding the search for a systematically unified science. Why, she asks, should a priori conceptions that have no application to empirical phenomena play any role in empirical investigation? Her answer is that, on Kant's account, the ideas function as optimistic placeholders for what there is to be found out in ongoing empirical investigation. On Zuckert's reading, Kant can maintain that the ideas guide empirical inquiry in the search for a systematic science precisely because they do not represent fully determinate, cognizable objects. As nearly empty presentations of objects that lie beyond experience, the ideas encourage us to search for a systematic conception of nature without, however, predetermining empirical science. In so doing, moreover, they indicate the limits of empirical investigation that will never fully satisfy the demands of reason.

In Chapter 6, Thomas Teufel returns to the question of how the principle of the purposiveness of nature relates to the necessity of empirical

laws. Teufel makes the case for distinguishing between two different roles the principle plays: transcendental and epistemic. According to Teufel, it is the transcendental function of the principle that wards off cognitive chaos. He suggests that, without presupposing the purposiveness of nature, the threat of a fundamental incompatibility between sensible particularity and conceptual universality would undermine the possibility of human cognition. Furthermore, Teufel argues that the principle entitles us also to consider well-established regularities in nature as necessary and, hence, as laws. The principle of the purposiveness of nature thus serves as the rationale behind the "Maxim of the Lawfulness of Empirical Laws." Teufel construes this maxim as instrumental but not transcendental: it warrants attribution of a material form of necessity to empirical laws of nature.

Nomic necessity and the metaphysics of nature is the overarching theme of the chapters in Part III. If the source of the lawfulness of nature has to be found in the spontaneous legislative acts of our faculties (be it the faculty of understanding, of reason, or of reflective judgment), it might be tempting to read Kant as noncommittal about the metaphysics of laws. Yet, building on recent scholarship, in Chapter 7 James Messina argues that Kant defends a "bottom-up" Necessitation Account of laws of nature, at a distance from traditional readings of both constitutive a priori principles and regulative principles of systematicity. The bonus of the Necessitation Account is that the necessity and universality of the laws can be regarded as supervening on the natures of things (instead of being injected by our cognitive faculties). This reading chimes with contemporary debates in philosophy of science about laws of nature and their nomic necessity. But it also invites us to reconsider Kant's (by and large) underrated metaphysics of nature. By drawing on various primary sources Messina makes the case for a re-evaluation of Kant's metaphysics of nature as central to Kant's Necessitation Account of laws.

In Chapter 8, Michela Massimi sets out to address what she calls the Kantian problem of inference (echoing Bas van Fraassen's objection against David Armstrong's Necessitarian Account of Laws). In its Kantian version, the problem of inference is the problem of explaining how the necessity of effects in nature can be inferred from the Kantian premise that the understanding "prescribes" laws to nature. For it would seem that the understanding could prescribe laws to nature only in a formal sense (qua *natura formaliter spectata*), and not in any genuine real sense. If this (broadly transcendental idealist or projectivist) reading were correct, laws of nature could not possibly be necessary in the genuine sense of prescribing the way nature ought to be. For laws would not have

any purchase on nature itself: they would not make any effect in nature necessary. Against this reading, Massimi illustrates three kinds of necessity at play in Kant's account of laws. She explains the nomic necessity of empirical causal laws in terms of a metaphysically more robust picture emerging from Kant's lectures on metaphysics. By showing how nomic necessity ultimately rests on real grounds, and the modal claims associated with it, Massimi shows how Kant is equipped to provide a metaphysically more satisfactory answer to the problem of inference than originally suspected.

The metaphysics of force laws (i.e., the laws of attractive and repulsive forces) is the topic of Daniel Warren's Chapter 9. What grounds these two fundamental laws of nature, according to Kant? Is there any room for experience, given the a priori justification Kant gives to these force laws? Despite their metaphysical foundations, Kant clearly saw the need to supplement metaphysics with a mathematical treatment. Yet metaphysics takes once again a central role as soon as the details of the mathematical treatment turn out to impinge on the very concept of intensive magnitude. What are, for Kant, intensive magnitudes? And to what extent are they amenable to be represented mathematically? For example, are they subject to the mathematics of addition or subtraction (given that they are not extensive magnitudes)? These questions become all the more pressing for the laws of photometry and dynamics. For, in both cases, Kant seems to follow aprioristic lines of reasoning to explain the diffusion of the effects. Yet the very existence of the two fundamental forces cannot itself be known a priori.

Warren's analysis of the interplay between mathematics and metaphysics for the force laws paves the way to Part IV of the volume, dedicated to Kant's conception of laws in physics. Here, two chapters by Michael Friedman and Marius Stan illustrate in detail Kant's mathematization of nature and the resulting necessity of the laws of physics. In Chapter 10 Friedman builds on his previous discussion of causal necessity in Kant by bringing to light the legacy of Newton's methodology of "deduction from phenomena" in Kant and post-Kantian thinkers. On Friedman's reading, Kant endorses Newton's mathematical treatment of gravity as an impressed force and deduces the mathematical properties of such force (i.e., the inverse-square law) from empirical phenomena, such as Kepler's "rules." Kant's conception of force and causal necessity plays an important role in post-Newtonian physical science, in particular in the late-nineteenth-century history of electromagnetism, which eventually led to Einstein's relativity theory.

The legacy of Kant's metaphysical foundations for classical mechanics is Marius Stan's topic in Chapter 11. Despite widespread reports about the untimely death of Kant's metaphysical project in modern science, Stan argues that Kant's "metaphysics of corporeal nature" is still alive and well in modern classical mechanics (if understood primarily as Newton–Euler dynamics). Yet metaphysical problems arise as soon as one considers how modern classical mechanics is amenable to metaphysical treatment in terms of either discrete mass-points or a deformable continuum. Stan deals with both metaphysical difficulties and shows the extent to which Kant's metaphysical foundations can still be embedded in modern classical mechanics.

Finally, in Part V, the discussion turns to Kant's view on laws in the life sciences. Does Kant make room for biological laws? And, if so, what would such laws look like? Angela Breitenbach addresses these questions in Chapter 12 by asking how organic phenomena, famously construed by Kant according to regulative teleological principles, fit with his conception of the lawful unity of nature. Against the widely held view that organisms fall out of the lawful unity of nature on Kant's account, Breitenbach argues that Kant's teleological notion of the organism is compatible with a naturalistic conception of biological entities and, in particular, leaves room for the discovery of genuine biological laws. On her reading, Kant's teleological conception presents a means for identifying parts of nature as organic, thereby guiding the search for biological laws. Relating the Kantian discussion to proposals in the philosophy of biology today, Breitenbach suggests that Kant's approach to the life sciences reveals an idea of the systematic unity of nature whose conceptualization requires a multiplicity of mutually irreducible notions and types of explanation.

In the last chapter, Catherine Wilson traces the historical development of Kant's thinking on the science of living nature from his earliest writings on natural history to his mature theory in the *Critique of Judgment* and his late work in the *Opus Postumum*. Wilson shows how Kant's interest in organic nature leads him to address a number of separate though related problems. They include the ultimate origin of life, animal generation, and the extinction and transformation of species, and are unified by teleological concerns for the purpose of living nature. Against the widely accepted reading that Kant distinguishes the constitutive principles of the mechanical sciences from a regulative teleological approach in the life sciences, Wilson makes the provocative proposal that Kant maintains a constitutive belief in active, organizing forces throughout his career. While in his early writings he regarded such forces as unproblematic, Wilson

claims that Kant held on to the reality and efficacy of living forces even when, in his mature theory, he argued that living forces have to be construed according to an analogy with goal-driven, intelligent activity.

As the thirteen chapters in this volume show, Kant had a life-long commitment to the topic of the laws of nature. He came to develop a detailed account of the laws of nature in the physical and life sciences. This account reveals important interconnections between different parts of his vast opus – with similar themes running from the pre-Critical writings to the *Opus postumum*. More important, it reveals a continuity between Kant's theoretical and practical philosophy, and it demonstrates the central role that his metaphysics of nature played for his theory of knowledge. Last but not least, Kant's view on the laws of nature continues to offer a multifaceted and yet coherent image of nature, where the quest for unification does not translate into short-sighted reductionism. This image deeply influenced the course of scientific history after Kant. And it continues to speak to us today and to our ongoing concerns about the systematicity, universality, and necessity of the laws we observe in the physical and biological realms.