

## Andreas Bartels: *Naturgesetze in einer kausalen Welt*

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What laws of nature are is one of the most important issues and a long-standing debate in philosophy of science and in metaphysics. Among the conceptions that acknowledge the existence of laws, two main families can be naturally identified, each relying on opposite intuitions: one the on hand, the Humean conceptions privilege a descriptive and epistemic understanding of laws, in particular centred around the intuition about their contingency, whereas on the other hand, the non-Humean conceptions take an ontologically more substantive perspective on laws, relying on the opposite intuition about some fundamental nomological necessity. To some extent, any position in this debate faces a tension between these conflicting intuitions. In his book *Naturgesetze in einer kausalen Welt*, Andreas Bartels elaborates a non-Humean understanding of laws of nature that aims to pay heed to both intuitions, in particular by explicitly integrating contingency within a non-Humean, dispositionalist (and causal) framework. Indeed, Bartels actually considers the contingency of laws of nature as a kind of methodological principle of science, and of physics in particular—hence the name of his new conception of laws: methodological dispositionism. More broadly, Bartels' book belongs to the recent renewal of metaphysics of science or scientific metaphysics, here in the sense that considerations from contemporary fundamental physics play an important role in the metaphysical discussion (in particular, any satisfactory metaphysical conception about laws should be compatible with contemporary fundamental physics and with what Bartels calls its methodological praxis).

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The book is divided in five chapters, the first two setting the stage for the development of Bartels' own conception about laws and causation in the two central chapters (ch. 3–4), followed by a short concluding chapter on the relationship between metaphysics and physics. So, the first chapter provides an overview of the current debate between the main Humean and non-Humean conceptions about laws of nature, which are characterized as 'passive' and 'active' interpretations respectively. Through his review of the difficulties faced by Humean supervenience, Bartels shows his preference for an active, non-Humean account of laws. He is in particular dissatisfied with the epistemic approach to laws put forward by the Humeans (as in Lewis' best system analysis and refinements of it), since he is looking for what laws are *in the world*, not solely in terms of our epistemic capacities and interests (p. 34). Although sympathetic to the standard non-Humean, active conceptions of laws in terms of universals (Dretske, Tooley and Armstrong) or as fundamental, primitive entities themselves (Maudlin), Bartels still finds these approaches wanting. This is the case, because, according to Bartels, they do not really address the issue of the origin (and the nature) of the nomic necessity that constitutes what laws are in the world within this non-Humean framework.

These reflections naturally lead Bartels to consider in chapter 2 the conception according to which nomic necessity is grounded in the dispositional nature (essence) of physical properties. Indeed, according to dispositional monism, all fundamental physical properties are entirely metaphysically characterized in terms of what they do, that is, in terms of their causal effects; a fundamental physical property is therefore identified and individuated through its specific causal effects, and this is so with metaphysical necessity, that is, in all metaphysically possible worlds. As a consequence, laws of nature, which can be straightforwardly derived from the dispositional nature of fundamental physical properties, are then themselves considered as metaphysically necessary (i.e. as holding in all metaphysically possible worlds). But according to Bartels, this is too high a price to pay since such a conception violates the fundamental intuition about the contingency of laws. More importantly, Bartels argues that this metaphysical necessity is not appropriate for understanding fundamental physical properties, and in particular metrical properties within the framework of the theory of general relativity (§ 2.6). On the one hand, due to the dynamical nature of general relativistic spacetime, metric properties can naturally be understood as dispositional (and causal in some sense) in the general relativistic context (through the manifestation of tidal forces for instance). But on the other hand, Bartels argues, it seems illegitimate to consider that the effects of metrical properties (as expressed via the affine structure compatible with the metric) are metaphysically necessary in the strong sense of dispositional monism (alternative affine structures may well be empirically meaningful; at least there is no reason to think of the link between the metrical and affine structures as metaphysically necessary).

In chapter 3, Bartels elaborates his own dispositionalist account of laws, methodological dispositionalism, which aims to provide an active (causal indeed) conception of laws and of nomic necessity, while not having metaphysical necessity as a consequence. Within Bartels' proposal, laws are understood in terms of the contingent causal roles of the (fundamental) physical properties that are involved. These causal roles can be described by dispositions (for certain behaviours under certain conditions), but these latter do not constitute any independent (*sui generis*) entities on their own. These causal roles are contingent in the sense that they also depend on the contingent causal structure of the world (and so do not only depend on the nature of the properties, as within dispositional monism; properties do not only have dispositional aspects, they also have categorical 'characteristics'). Bartels argues that his methodological dispositionalism strikes the right balance

between necessity and contingency. It captures the right notion of some ‘contingent necessity’. On the one hand, the necessity of laws (nomic necessity) has its origin in the very causal roles of the fundamental physical properties (which confer some counterfactual stability). On the other hand, the contingency of laws is guaranteed in the sense that properties could have had the same categorical characteristics but different causal profiles (p. 131). This understanding of laws raises a host of issues, about the very causal understanding of laws—for instance, whether the Einstein field equations can genuinely be understood in causal terms—and about the categorical/dispositional distinction among others (these issues are addressed in § 3.3 and § 3.6). More generally, since Bartels explicates laws by appealing to causation (and to the causal structure of the world), the nature of this latter therefore needs to be clarified in order to avoid merely begging the question. This is the task of chapter 4.

After reviewing some of the main theories of causation (and their prospects in the context of fundamental physics) in § 4.1, Bartels focuses on the transfer (or conserved quantity) theory of causation, since it provides an account that is ontologically substantial enough (and empirically well-founded enough) to ground laws in the way required by methodological dispositionalism. It is however not entirely clear to what extent the transfer theory in itself can provide an account of causal asymmetry. Relying on the time asymmetry of most physical cosmological models, in particular, those for which a cosmic time function can be defined, Bartels argues that causal asymmetry is therefore a fundamental (but contingent) feature of our actual world (global time asymmetry is argued to ground local causal asymmetry in this context). It is in this sense that the causal roles of fundamental physical properties depend on the causal (and temporal) asymmetry of the world, as represented in physical cosmological models.

In the short concluding chapter, Bartels further discusses the role and status of contingency—crucial to his methodological dispositionalism—within the broader framework of the relationship between metaphysics and physics (science). He takes contingency to be a methodological principle of science that needs to be reflected in the metaphysics of science. More generally, Bartels considers the relationship between metaphysics and physics (science) as a kind of mutual exchange between the two fields, as exemplified by his discussion of the nature of laws—and in line with recent work on naturalized or scientific metaphysics.

In this spirit, Bartels’ book is extremely valuable, bringing a central metaphysical debate such as the one about laws of nature closer to fundamental physics and exemplifying the fruitful interplay between metaphysics and physics. Actually, in many ways, Bartels could have further explored this interplay: in particular, more systematic considerations from fundamental physics could be extremely relevant for the argumentation of the book and for the debate about laws of nature in general. For instance, careful attention to the dynamical features of general relativistic spacetime (and to possible quantum gravitational generalizations thereof) may actually raise some important difficulties for the (ontologically) fundamental status attributed to (the asymmetry of) cosmic time and to conserved quantities (such as mass-energy) within the framework of methodological dispositionalism. Indeed, the existence of a cosmic time function is a strong global topological assumption, one that may only hold at a coarse grained level. Similarly, strictly speaking, mass-energy(-momentum) conservation, for instance, is linked to certain symmetries of the spacetime structure (temporal and spatial translation invariance), which may be absent in the fully dynamical context. Bartels’ methodological dispositionalism would also have benefited from a more elaborate articulation in the quantum domain, beyond merely situating his conception with respect to the current literature. Indeed, large parts of the book

are about reviewing the relevant positions in the various debates about laws, dispositions and causation—in this sense, the book can also be very useful as teaching material—but maybe at the cost of deeper elaborations of Bartels' original conception.

In any case, Bartels' book constitutes an important contribution to the debate about laws of nature, in particular in a metaphysics of science perspective, and offers many stimulating thoughts (e.g., about the categorical/dispositional distinction). Thus, the English speaking readers would welcome a translation.