of geometry that deals with motion, and investigates, apodictically and using geometrical reasoning, the force with which such and such a motion takes place" (2). Just like Newton in the *Principia*, in *Mechanica* Wallis uses curves (e.g., the cycloid) whose exactitude was denied by Descartes. Yet the algebraic style of Wallis's proofs indicates his acceptance of Descartes' mathematical methods. He thus appears to have other grounds for rejecting the geometrical/ mechanical distinction. Further illumination might still be gained by studying the motives of such contemporaries and the extent to which Newton is moved by them.

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Michela Massimi, ed. *Kant and Philosophy of Science Today*. Royal Institute of Philosophy Supplement 63. Cambridge: Cambridge University Press, 2008. Pp. 204. $31.99 (paper).

In July 2007, some eight historians and philosophers of science met in London to ask how Kant's ideas could guide philosophical reflection on exact science in the last 2 centuries. Michela Massimi edited the fruit of their encounter into *Kant and Philosophy of Science Today*. It appears that Kant's insights still inspire general philosophy of science, and Kantian themes informed the foundations of mathematics and physics.

In "Why There Are No Ready-Made Phenomena," Massimi enlists Kant to help us end the standoff between scientific realists and constructive empiricists. Both parties, she contends, take "phenomena" to be "ready-made" or unproblematic in two senses: realists see them as manifestations of a hidden reality, whereas for constructivists they are allegedly knowable without commitment to any theoretical, unobservable entities. Massimi urges both to reexamine their assumptions with an eye to Kant's dictum that phenomena are constituted— by us. Realists should avoid the antinomies to which their *transcendental* realism is condemned and doomed, and constructivists should remember that "somehow we *make*" phenomena (26), and that requires "inserting" unobservables into our theories if they are to be theories at all. Massimi illustrates the latter point by a detailed reading of Kant's philosophical interpretation of Galileo's kinematics of free fall.

Current physics aims to unify theories, forces, and formal methods—an undeniably Kantian theme. Margaret Morrison, in "Reduction, Unity, and the

Nature of Science," cautions against the rush to reach for Kant in this context. One drive for unification, she explains, comes from physics itself (e.g., taking the symmetries of the fundamental groups as heuristic) instead of from the strictures of reason, as Kant himself would have it. Further, the reduction aimed at (e.g., of the four fundamental forces to one) is strongly ontological and so decidedly un-Kantian. High-energy physics sees the unified force it chases as transcendentally real, instead of modestly introduced for the sake of theory yet unattainable, as Kant soberly advised. In this sense, current physics is not Kantian but neo-Cartesian, built around highly complex "objects of geometry made real."

Although physics might not be Kantian, two of its eminent theorists were consciously so. Thomas Ryckman, in "Invariance Principles as Regulative Ideals," reads Eugene Wigner's triad of initial conditions, laws of nature, and invariance principles—explicitly proposed as a mental "artifice" needed to make "the natural sciences possible" (64)—as redolent of Kant's doctrine that cognition is the product of intuitions, concepts, and ideas of reason. Ryckman absorbingly argues that this Kantian bent strongly resembles certain strands in Hilbert's axiomatization of relativistic physics. In particular, Hilbert saw his "axioms of invariance" as regulative principles needed to guide and constrain the search for laws or dynamical equations of motion.

In "Einstein, Kant, and the A Priori," Michael Friedman illustrates his program for reviving Kantianism in historicist garb. Kant believed his transcendental principles to be true forever because they are (1) rooted in immutable structures of the mind and (2) needed to ground geometry and dynamics, which he took to be complete and unrevisable. In the meanwhile, faith in transcendental psychology has been on the wane, and Euclidean geometry and Newtonian kinetics were demoted to local theories. Then, all prospects for a robustly Kantian philosophy of science appear doomed—it is the inexorable fate of theories to yield to contingent successors. Yet Friedman sees hope, if only we let him replace Kant's *Konstitutionstheorie* with a richly philosophical history of science. First, he offers the "relativized a priori," for which he has argued at length elsewhere: certain principles count as transcendental relative to individual theories because they are extratheoretical assumptions uniquely compatible with the "inner logic" of the theories they ground. Second, to offset the loss of transcendental psychology, Friedman submits that theory change is rational because it too has an inner, although diachronic, logic: each new theory shows its predecessor to be a special case or a local restriction. In Friedman's account, Einstein and Kant are part of the same historical project: to offer a priori, thus transcendental, constitutive principles in which to ground inertial structure for the "new mechanics," namely, Kant's absolute space for classical dynamics, Einstein's equivalence principle for his theories of relativity.

Friedman's is a heady tableau: gravitation theory as the unfolding of reason. Although not all may embrace Friedman's construal of Kant's absolute space, all should take note of his insight that Kant—like Newton, Poincaré, and Einstein—saw clearly that a philosophy of space is unfinished unless coupled successfully with a theory of motion.

Hasok Chang offers a different route for neo-Kantianism, inspired by C. I. Lewis's heterodox reading of the a priori. In "Contingent Transcendental Arguments for Metaphysical Principles," Chang submits that some metaphysical tenets could be justified "transcendentally"—as presuppositions necessary for certain activities (e.g., scientific endeavors), which are in turn contingent. The necessity at work here is pragmatic: the epistemic activity would be pragmatically impossible without presuming the (a priori) truth of the relevant "transcendental" principle. In partial fulfillment of his manifesto, Chang outlines a short list of such principles and issues a tantalizing promissory note to articulate them more fully in a "philosophy of scientific practice" that could do justice to the complexity of modern physics.

If Friedman and Chang take neo-Kantianism out to sea, Roberto Torretti stays quite close to shore. In "Objectivity: A Kantian Perspective," he thinks the downfall of Euclid's and Newton's theories spells the end of much in Kant—perhaps too much. Not only the a priori forms of sensibility must go, but so do any fixed categories, he contends. Ideas of reason, presumably, fare no better. What is left of Kant, then? It is merely the insight that objectivity is constituted, not given; philosophically, all it requires is the idea of "combination or composition as such," in order to "secure maximal freedom for Kant's productive imagination or reflective judgment" (93). This is meant to make Kant safe for the present—all too safe, I surmise, for in this weak guise little could threaten it.

In "Arithmetic from Kant to Frege," Daniel Sutherland skillfully shows that Frege's critique of attempts to ground number concepts in representations of "pure" (i.e., qualitatively indistinguishable) units shares important elements with Kant's views on the limits of representing by concepts. The two do differ, however, in their proposed response to the problem. On the view they both reject, (natural) numbers are collections of "pure units." On the basis of an epistemological principle of the Identity of Indiscernibles, Kant argues that numbers would be unknowable through concepts alone: any attempt to represent several (qualitatively) identicals (e.g., five units, as the concept "five" supposedly does) collapses into representing just one thing. Yet Kant inherits from tradition the view that numbers are collections of pure units. Thus, he must confront what Sutherland calls the pure plurality problem: a tension between (1) the need to think of units as completely general, not distinguished from one another by any qualities, and (2) the need to mark off each unit so as to be able to distinguish it from the others. Kant's stratagem is to mobilize intuition: the pure intuition of space lets us represent that which is identical in all qualitative respects yet distinguished *in numero* (e.g., by intuiting completely similar dots or strokes at different locations). It seems that nineteenth-century expounders of algebra and analysis—R. Lipschitz, E. Schröder, J. Thomae in Germany, and S. Jevons in Britain—ignored both the pure plurality problem and Kant's solution to it and, hence, made easy targets for Frege's attack. There is more, but I will not spoil the reader's delight in following for herself the rich strands of Sutherland's argument.

Kant's resort to intuition in mathematics forced him to admit that we have an intuitive grasp of space itself as a given (i.e., actual) infinity. Elsewhere, though, Kant denies that we could intuit empirical infinities. This leads to tension, which Carl Posy deftly defuses in "Intuition and Infinity." He then follows insightfully the subtle interplay between intuition and infinity into the twentieth century to explain how Brouwer chose the former at the expense of the latter, whereas Hilbert adopted a firmly infinitary basis for mathematics.

The overall impression is that, if any early modern still matters to modern science, it is Kant; the papers in this volume expertly vindicate that claim. Still, I cannot help but side with Morrison and note that this volume, perhaps unintentionally, urges us to ponder another question too: Just how robust is the Kant we could legitimately reclaim for today's science? Clearly, reading him leads us to ask key questions about the conceptual basis of mathematical physics. But answering them in a Kantian vein yet informed by the present requires us to forsake so many of Kant's distinctive traits—his separation of sensibility and understanding and view of their immutable forms, his account of reason and resolute idealism—that we may see the appeal to Kant as rhetorical, first, and substantively philosophical, second.

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Readers of *HOPOS* are certainly concerned not only with the history of the philosophy of science but with the history of science itself. They know,