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The Relevance of Kant's Philosophy for Nineteenth Century Science

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M. Friedman and A. Nordmann (eds), *The Kantian Legacy in Nineteenth-Century Science*. Cambridge, Mass: MIT Press, 2006. Pp. 370. US$45.00, £29.95 HB.

Recent times have witnessed an increasing level of interest in Kant's transcendental philosophy on the part of philosophers of science. Not only did Kant's philosophy and neo-Kantianism at the beginning of the twentieth century deeply influence the logical positivist movement, and hence the very same roots of philosophy of science as a discipline (e.g., M. Friedman, *Reconsidering Logical Positivism*, 1999; and *A Parting of the Ways: Carnap, Cassirer, Heidegger*, 2000), but, together with Husserl's phenomenology, they have also proved pivotal to the understanding, interpretation and reception of relativity theory in the twentieth century (see T. Ryckman, *The Reign of Relativity*, 2005). In the light of this increasing level of interest in Kant's philosophy, Friedman and Nordmann's volume constitutes an essential addition to the existing literature. This splendid book – carefully edited with a thorough twenty-seven-page bibliography – sheds light on various major aspects concerning how the Kantian legacy could reach the twentieth-century physical sciences by reconstructing the far-reaching impact that Kant's philosophy had on nineteenth-century sciences in the first place. There are at least five main aspects of the Kantian legacy addressed in the book across various articles. I summarise them briefly here, at the cost of simplifying and not doing justice to the great complexity of the material covered in each article.

The first aspect concerns of course the crucial role that Kant's dynamic theory of matter exposed in the *Metaphysical Foundations of Natural Science* (1786) played for the Romantic *Naturphilosophie* of Schelling, Schlegel, Goethe, and Novalis, among others (see Beiser's and Richards' articles). In the chapter on the Metaphysical Foundations of Dynamics, Kant famously schematized the empirical concept of matter according to the category of quality as the 'movable' that fills a space through a moving force. He identified two fundamental moving forces in nature: a repulsive force responsible for matter's impenetrability and an attractive force counterbalancing the repulsive force. Kant's aim was to start with these two a priori established moving forces in order to provide a 'top-down' justification for his three laws of mechanics, and hence for the three corresponding Newtonian laws of motion. The transcendental principles of substance, causality and reciprocity (providing the transcendental backup for Kant's three laws of mechanics) came in this way to play a *constitutive* role for the objects of experience. This top-down procedure found its natural counterpart in a 'bottom-up' procedure that Kant increasingly developed from the *Critique of Judgment* (1790) to the 'Transition from the Metaphysical Foundations of Natural Science to Physics' in the *Opus postumum*. According to this alternative procedure, we should start instead from empirically given forces of matter and from empirical laws, such as those that the chemical revolution was discovering at the end of the eighteenth-century, and try to subsume them under higher-level yet still empirical laws so as to seek after a system of forces in nature. *Systematicity* or *systematic unity* in the investigation of nature was presented as a *regulative* (as opposed to *constitutive*) principle of scientific inquiry. For Kant, the distinction between constitutive and regulative principles marked the distinction between the faculty of understanding, on the one hand,

and the faculty of reason and later (in the third *Critique*) the faculty of reflective judgment, on the other hand. It was precisely this demarcation between understanding and reason, between constitutive versus regulative principles that the Romantics dismantled.

The *Naturphilosophen* rejected the dualism between constitutive and regulative principles. Moreover, they gave a constitutive twist to the regulative principle of systematicity and to the teleological judgment about a purposiveness of nature, which Kant had defended as a purely regulative idea in the *Critique of Judgment*. The upshot of this manoeuvre for the *Naturphilosophen* was to show that by starting with Kant's dynamic theory of matter it was possible to explain how nature dialectically evolved from the inert/lifeless matter described by Kant into the variety of forms described by contemporary chemistry and biology. In this particular light, we should read Goethe's morphological studies of living organisms as well as Schelling's *System of Transcendental Idealism* (1800).

But there was also a second aspect of the legacy of Kant's dynamic theory of matter for nineteenth-century science. Schelling's reinterpretation of Kant had important implications for the history of electromagnetism in the early nineteenth century. Michael Friedman, in his beautiful article, reconstructs how Hans Christian Oersted's discovery of electromagnetism was deeply influenced by both Schelling's *Naturphilosophie*, which Oersted came to know via Johann W. Ritter, and by the new electrochemistry. Electrochemistry showed how chemical forces are ultimately electrical. Schelling, on the other hand, provided the philosophical framework for extending Kant's theory of matter beyond attraction and repulsion and for regarding magnetic, electrical and galvanic forces as a 'dialectical' development of these two fundamental forces of matter.

The Kantian legacy for nineteenth-century science was not, however, confined to the more experimental aspects of the new chemistry, electromagnetism and biology. It extended also to more theoretical aspects of mathematical physics. Frederick Gregory's and Helmut Pulte's articles, for instance, focus on the reinterpretation of the Kantian distinction between understanding and reason, constitutive and regulative principles in Jakob F. Fries' *The Mathematical Philosophy of Nature* (1822). In the same aforementioned spirit of rejecting the constitutive/regulative distinction and affirming the priority of the regulative over the constitutive, Fries saw Euler and Lagrange's principles of analytical mechanics as the result of a bottom-up approach for systematizing mechanical experience before any constitutive principle could be found and any forces of matter identified.

Even more striking was the impact of Kant's transcendental aesthetic for nineteenth-century geometry with the discovery of non-Euclidean geometries. This is the topic of Robert DiSalle's intriguing article dedicated to Helmholtz's sophisticated empiricism and its connection with Poincare's conventionalism. For Kant, the universal and necessary status of Euclidean geometry could be traced back to the fact that objects are given to the mind in intuition according to space and time as a priori forms of sensibility. Helmholtz challenged Kant on the allegedly necessary status of Euclidean geometry by showing that what makes space seem Euclidean is a series of sense-impressions about the free mobility of rigid bodies and paths of light rays, and the very same empirical evidence can acquaint us with the structure of a non-Euclidean space; hence the non-necessary status of Euclid's fifth postulate. In this way, Helmholtz's empiricism paved the way to Poincare's conventionalism about geometry, which is the topic of Jeremy Gray's, Janet Folina's, and Jesper Lützen's articles, whereas Timothy Lenoir's contribution concentrates on Helmholtz's theory of perception and *Physiological Optics* (1860).

However, the analysis of Kant's legacy would have been incomplete if it had stopped at this point. The fifth essential aspect covered in Friedman and Nordmann's book concerns the impact of Kant's philosophy more directly on the epistemology of the late nineteenth century. Alan Richardson's article beautifully investigates the link with the Marburg School of Hermann Cohen. Michael Heidelberger focuses on Alois Riehl and Moritz Schlick. And Alfred Nordmann's article encompasses Riehl, Cohen and Charles S. Peirce's pragmatism and its debt to Kant. An analysis of these philosophical points would lead me far from the scope of this review, and I shall not pursue it here. It suffices to say that Richardson's analysis of Hermann Cohen's neo-Kantianism constitutes a very welcome contribution to one of the most relevant (and often overlooked) figures of the Marburg School: Cohen's reinterpretation of Kant's theory of experience in the light of the history of mathematical physics with the calculus and infinitesimals represents indeed a landmark for neo-Kantianism.

But there is more. Cohen's neo-Kantianism illuminates also a subtle and often forgotten link between epistemology and philosophy of science, which is perhaps one of Kant's most enduring lessons for current philosophy of science. Philosophy of science is not just a branch of epistemology; nor is it meant to be a replacement for it, following Rudolf Carnap. Instead, in the words of Alan Richardson:

> science serves both as a resource in the fight against metaphysics and its sceptical antithesis and as a problem for transcendental philosophy. More precisely, and to anticipate some language we shall see in use among the Marburgers, the fact of science explodes scepticism and humbles metaphysics, while the philosophical account of scientific objectivity becomes the highest speculative burden of transcendental philosophy (p. 216).

In our time, where metaphysics still animates most debates in philosophy of physics while scepticism *a` la* van Fraassen is rampant in empiricist quarters, this is probably the most enduring aspect of the Kantian legacy that we *should* have inherited from the nineteenth-century science.