

**Kant's metaphysics of nature and mathematical construction.
On Michael Friedman's *Kant's Construction of Nature***

***La metafísica de la naturaleza de Kant y la construcción
matemática. Sobre Kant's Construction of nature de Michael
Friedman***

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Review of Michael Friedman, *Kant's Construction of Nature: A Reading of the Metaphysical Foundations of Natural Science*, xix + 646 pp., Cambridge University Press, Cambridge 2013. ISBN: 978-1107515451

Kant's Construction of Nature is an extraordinarily thorough and stimulating reading of one of Kant's most difficult and underestimated works, the *Metaphysical Foundations of Natural Science* (MFNS). It also represents, as the author himself recognizes, the «culmination of an intellectual journey of more than thirty years» (p. ix). If one considers Friedman's first book on this topic, *Kant and the Exact Sciences* (1992), followed by the English edition and translation of the MFNS (2004) and by a number of important articles, this book appears as the accomplishment of a double methodological objective. First, Friedman wants to consider Kant's lifelong engagement with the natural science of his time as the «best way» to inquire into the relationship of Kant's views to successive scientific developments and in particular to «our modern (Einsteinian) conception of space, time and motion» (p. xi), thus considering Kant's philosophical understanding of natural science as the beginning of a «conceptual transformation» that eventually led to modern philosophy of science. Second – as it appears more and more evident in the course of

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Friedman's studies – the pursuit of the first objective involves reading Kant's writings on natural science in their original historical and systematic context, thus contrasting the way most of the scholars which have been positively interested in a reappraisal of Kant's philosophy of science have separated the *Critique of Pure Reason* from the *MFNS* and other writings on natural science. There has been indeed a tendency of considering the *MFNS* as a provisional exposition of Kant's views on Newtonian science, which could be neglected while focusing on Kant's general methodology and less historically contingent philosophical ideas. This is not only true of prominent Kantian scholars in the Anglo-american world such as Peter Strawson and Gerd Buchdahl (cited by Friedman as the first sources of his scholarly interest into the topic), but also of the Neokantian philosophers of the Marburg School, which have been among the major supporters of a Kantian view in early XXth Century epistemology and have also been the object of Friedman's own research. The decision to focus on the argumentative intricacies of Kant's «metaphysics of corporeal nature» in the *MFNS* is a telling aspect of Friedman's opposite (and correct) view, that the *MFNS* represent a substantial part of Kant's philosophy of natural science and also an essential text for the understanding of the whole critical philosophy.

The book closely follows the structure of Kant's *MFNS*. After addressing the «place of the *MFNS* in the critical system» in the Introduction, Friedman analyses the four sections on “Phoronomy”, “Dynamics”, “Mechanics” and “Phenomenology” in separate chapters. He then turns back to the general interpretation of the work in the Conclusions. By following this plan Friedman does not provide a commentary to the work, although he abundantly quotes the text and does not leave virtually any single line out of his analysis. Friedman's reading aims at reconstructing the unitary conception of the *MFNS* and considers the different chapters and single propositions of the book as elements of a single systematic argument. The connection of single passages of the text with parallel passages in other writings shows that Kant's new systematic argument rigorously depends on philosophical and physical doctrines defended in other writings (especially in the *Critique*) and at the same time involves an illumination and – in a number of cases – a radical modification of Kant's previous views. This approach leads to a first general result: contrary to a view which has dominated the literature on the *MFNS* (starting from the seminal book *Kant als Naturforscher* by Erich Adickes 1924-25) and is still widespread today among Kantian scholars, Friedman clarifies that the *MFNS* cannot be taken to reproduce the account of physical doctrines that Kant had already defended and metaphysically grounded in previous writings, such as the dynamical theory of matter and the Newtonian laws of motion. In spite of the obvious analogies, the new framework provides a new, complex account of this material, with original results. Even when single doctrines appear unaltered – as with the relativity of motion or the law of inertia – they result from different and generally more detailed premises.

This approach is also particularly useful in order to grasp the crucial importance of the *MFNS* in Kant's philosophy. In the Introduction Friedman describes this systematic

connection of critical philosophy and the new «metaphysics of corporeal nature» by highlighting how many significant modifications in the Second Edition of the *Critique* were inspired by the realization of the MFNS. The most important of these modifications is Kant's statement that only the «general doctrine of body» can provide «examples (instances *in concreto*)» of categories and principles of the intellect, and thus to general metaphysics». This statement appears first in the *Preface* to the MFNS (AA IV, 478) and then is repeated, with almost the same words, in the new “General Note on the System of Principles” (KrV B 291). This «exhibition» of concepts by means of outer intuition provides indeed a necessary integration of the schematism chapter of the *Critique*, for the former actually provides an objective reference («sense and meaning») to categories, while the latter merely proved the possibility of their intuitive realization. Friedman clearly outlines this systematic role of the MFNS, commenting on different perspectives advanced by recent scholars (I will come back to this general point in my final remarks). This «realization» of categories, on the other hand, corresponds to the «foundation» of Newtonian mathematical physics by means of a metaphysics of Leibnizian tradition (p. 17). This latter point has been widely acknowledged by scholars and, of course, it is generally true of the whole of Kant's writings on natural philosophy. As a matter of fact Kant directly quotes Newton and largely reflects on the *Principia* and *Opticks* in the MFNS. But this reference to Newton is precisely one of the sources of the already mentioned dismissive attitude in previous scholarship. Ernst Cassirer, for example, considered the MFNS as a work of limited interest, because it would provide – as he writes in his book on *Einstein's Theory of Relativity* (1921) – merely a «philosophical transcription» (*Umschreibung*) of Newtonian principles of natural science. Friedman's book sets out a quite different view: the MFNS involve both a substantial clarification of Kant's new idea of metaphysics, as involving both a priori and empirical elements, and the result of Kant's lifelong *critical* confrontation with Newtonianism. This renders all the more urgent an exact clarification of how Kant realizes the systematic idea of a metaphysics of corporeal nature, which had been merely announced in the *Critique*, and how thereby the new “foundation” of Newtonian science actually takes place.

This clarification is very important for Friedman's wider epistemological objective. As it turns out, Kant's critical reconstruction eventually questions some of the claims «postulated» by Newtonian «natural philosophers» with their effort to avoid metaphysical hypotheses (AA IV, 472). Hence this “foundation”, rather than taking for granted Newton's physics and adding new metaphysical principles as an “explanation” of the latter (which was the thesis of Buchdahl), involves a deep critical reassessment of Newton's original concepts and principles. Newton's views are also explicitly reformed on a number of points, including the conception of absolute space as an idea of reason, the conception of gravity as an essential property of matter and the rejection of absolutely hard bodies, while the whole system of definitions – from density to quantity of matter – is substantially reviewed with regard to the origin of concepts and their conditions of application. This critical view of Newtonian science, now, appears precisely as the beginning of the

«conceptual transformation» which, according to Friedman, connects Kant to post-Einsteinian epistemology.

Given the richness of Friedman's reading I will now review only selected examples of his analyses, that appear particularly helpful in order to show the originality of its results. I will focus on the chapters on "Phoronomy" and "Dynamics", as these chapters address the most debated methodological and doctrinal issues of the work.

The chapter on "Phoronomy" includes first of all a clarification of Kant's concept of movement and its role for the establishment of the principles of physics. Interpreters have usually devoted limited attention to this short chapter on the «pure doctrine of motion», which includes a single theorem on the composition of movements. Yet it plays a prominent role in Friedman's reading, as it sets the ground of what I have called Kant's single systematic argument. As Friedman observes, the concept of motion is the first example of the «interpenetration» of empirical and mathematical elements in Kant's theory (p. 88). The empirical concept of motion requires the perception of outer objects in *space*, which is in turn a condition for the representation of a system of reference («material space») and also first makes possible to consider *time* as a magnitude. On the other hand, motion can be constructed as a continuous magnitude in pure intuition and this is what makes it the basic concept for the new metaphysics of corporeal nature as an investigation of the «principles for the construction of the concepts that belong to the possibility of matter in general» (AA IV, 472). In particular, the «principle» of the relativity of motion, which allows the alternative attribution of instantaneous motion to a moving point in empirical space or of the contrary motion of this space in a larger system of reference, will indeed play a fundamental role in Kant's proofs of fundamental theorems in subsequent chapters.

Friedman carefully separates these different elements of the theory of motion and highlights how Kant's account reflects Newton's procedure for defining relative (sensible) and absolute space (which had already been the object of analyses and original insights in *Kant and the Exact Sciences*). In particular Friedman shows how Kant's treatment of absolute space as an «idea of reason» generalizes Newton's original method for the determination of an inertial frame of reference and for establishing a single frame of reference for different phenomena, while reforming Newton's original account, which Kant takes to be burdened by metaphysical elements (notably, absolute space is considered as an «object»).

Friedman's analysis of the "Dynamics" chapter presents similar features. Kant's dynamical theory of matter, which is the most debated single doctrine in the reception of the MFNS, is carefully connected to the new systematic framework. Friedman highlights the role played by the conception of motion and its relativity for the proof of Theorem 1, which introduces a fundamental repulsive force as the cause of the filling of space, arguing that this connection «represents the most fundamental difference between the exposition of

the *Metaphysical Foundations* and in the pre-critical writings where it was originally developed» (p. 99), namely in the *Physical monadology* of 1756. First he argues that, in Kant's present account, the construction of motion is a necessary condition for the knowledge of any scientific concept and this is the reason why force, being the *cause* of motion, cannot be constructed (pp. 221-234). On the other hand, he argues that the «full exhibition of the objective reality of the concept of a repulsive force must await the full explanation of how all the pure concepts of the understanding are instantiated or realized together in the metaphysical doctrine of body» (p. 120): that is, Kant's new dynamical theory cannot be separated from the successive chapters, in particular from the account of material substance in the "Mechanics" chapter, where the mathematical construction of motion again plays a major role (see in part. p. 145).

Friedman then insists on how the new dynamical theory of matter, although similar in some respects to the one developed in the *Physical monadology*, is actually a quite different theory with a different argumentative ground. The initial introduction of repulsive force (Theorem 1) depends on the intuitive composition of instant velocities in the construction of resistance to penetration – empirically given by the phenomenon of impenetrability – and is thus considered as an effect of repulsive force without making any reference to point-like monads. Indeed, as Friedman rightly stresses, the new theory involves (Theorem 4) the representation of matter as a continuum, where every single point can be considered as the origin of a repulsive force. Friedman's analysis of the proof of this theorem emphasises once more the role of the mathematical construction of movement: the apparent obscurity of the argument is illuminated by a brilliant reference to Kant's procedure for constructing interaction between substances, which is expounded in the "Mechanics" chapter (pp. 149-154).

On the whole Friedman, in his analyses of these two pivotal theorems of "Dynamics", insists on the scientific consistency of Kant's arguments – where many interpreters have found flaws – by making very subtle references to both the mechanics of the time and Kant's unitary "phoronomical" approach in the MFNS. This feature of Friedman's reading, which was already evident in *Kant and the Exact Sciences*, leads to extremely ingenious and yet, sometimes, to somewhat historically abstract reconstructions, based on general models of Galileian and Newtonian mechanics and astronomy. However, compared to the previous book, Friedman now uses more historically rich references for his analyses. One excellent example is the discussion of Kant's «continuum theory» of matter in the light of Euler's fluid mechanics (pp. 137-142). Elaborating on references to Euler in the MFNS and other writings, Friedman is able to flesh out the mathematical models in fluid mechanics which Kant may have been thinking to while passing from a monadological theory, centered on the representation of the particle, to the continuum theory. More generally, in this book, Friedman appears now more sensitive to the fact that Kant's model of natural science, even when his object is mathematical physics, substantially includes post-Newtonian developments and that, hence, Kant's target is not

just *Newton's* science, but rather – as Friedman puts it in a passage of the *Preface* – the «largely *Newtonian* science of his time» (p. ix, my italics).

One of the most interesting achievements of Friedman's book is his analysis of the ether problem and its connection to the theory of the fundamental repulsive and attractive force. This is one of the most complicated problems of the MFNS and of Kant's philosophy of natural science in general. As Friedman points out, Kant first introduces the necessary action of a fundamental attractive force, opposed to the fundamental repulsive force, in order to set a necessary limit to the expansion of matter and later clarifies that this counterbalancing action actually arises from the action of an external matter, ether (pp. 192-202, cf. 210, 228). Friedman rigorously separates a priori and empirical considerations in Kant's argument: the pure phoronomical construction of contrasting movements is sufficient to introduce the action of forces, while the mechanical compression would be concretely operated by the ether. In the "Dynamics" chapter he does not discuss the issue of whether the role played by this hypothetical material may affect the a priori validity of Kant's counterbalance model. This crucial point is only indirectly touched in the conclusions and I will comment on Friedman's position below.

One more important achievement of Friedman's reading is the analysis of how Kant defends universal gravitation as an essential property of matter. This analysis had been largely anticipated in Friedman's previous works and provides one more example of how Friedman looks for the deeper meaning and consistency of Kant's arguments by considering their scientific references in considerable detail. Here Friedman argues that Newton's procedure for establishing the proportionality of gravitational attraction to body's masses involves the application of the Third Law Of Motion to interactions among primary bodies in the solar system. This convincingly explains why – according to Kant – Newton's denial of an «original attraction» would set Newton «at variance with himself» (AA IV, p. 515).

The sections on "Mechanics" and "Phenomenology" provide more penetrating insights into less studied details of Kant's MFNS, and hence constitute one more valuable aspect of the book. Rather than review more examples, though, I want to make some conclusive, general remarks on Friedman's reading.

Friedman's general objective, as we have seen, is to highlight the consistency of Kant's argument, by combining a close textual analysis with the investigation of Kant's scientific references in both mechanics and chemistry (for the latter see in part. 234-258). This double line of investigation works excellently in clarifying the complex and partly obscure inner architecture of the MFNS, while leaving aside the question of its ultimate validity and limits (as primarily dependent on the limits of the science of Kant's time). But some passages of Kant's argument do not seem to work even in this perspective. For example, as we have seen above, Friedman recognizes that the role of the ether in Kant's new "balancing" argument in the "Dynamics" is that of a «(mere) empirical hypothesis»

(p. 512 n). This separation of metaphysical from physico-hypothetical element reflects indeed the letter of Kant's text, but does not exhaustively eliminate (at least) two different problems.

First, there is a problem on the side of the "foundations of physics": the transition from the pure schematized representation of the conflict of realities to the physical one appears problematic or circular – as it has been argued in a number of ways by different scholars, including Burkhard Tuschling and Eckart Förster. Let me try to basically explain the problem and what I take to be Friedman's solution: on the one hand, forces in Kant's pure dynamics are conceived as acting on a point, which schematically represents matter (as endowed with density), while this matter cannot be constructed a priori; on the other hand, the empirical representation of a compressing ether already involves the position of matter as endowed with precisely the mechanical properties which render mechanical interaction possible (density, in the first place) and which should have been explained by the action of forces. Friedman's solution is that Kant introduces forces as *principles of the construction* of the filling of space by means of the schematic representation of opposite motions, while the *actual construction* requires more empirical conditions (such as the specific difference of material elements, the existence of ether as a «World-matter», its extremely low density, etc.). This solution deserves a deep consideration. From the hermeneutical point of view, its advantage is to defend the consistency of Kant's ideas in the MFNS, where other scholars (from Adickes to Förster and others) insist on the fact that Kant would have *later* modified and expanded his views, in particular in the *Opus postumum* manuscripts, thus recognizing that the previous account was flawed. Friedman, having himself provided a very rich account of the *Opus postumum* in different chapters of *Kant and the Exact Sciences*, is well aware of these hypotheses and firmly defends the consistency of Kant's published work *contra* later minor and/or unpublished writings, which do not present a comparable systematic account.

I think that this solution, convincing as it may be in order to separate the pure and the empirical elements of physics and then solve the foundational issue, opens a second problem, which affects Kant's *metaphysical* project. If Kant's theory merely demonstrates the conflict of forces in points and does not provide any construction of bodies (or matter in any other state of aggregation), it is not entirely clear how the new «metaphysics of corporeal nature» can provide «examples *in concreto*» for metaphysics. Friedman's position on this point can be derived from the "Conclusions", where he returns to the general point of the systematic function of the MFNS. He rightly claims both that (*contra* Buchdahl) the MFNS contain an *essential* and *additional* systematic element which the *Critique* could not provide – the concrete «exhibition» of concepts – and (*contra* Förster) that this addition is *not* a necessary element for the accomplishment of the *transcendental deduction*, but rather regards a different point: the «instantiation» of transcendental principles (p. 564). He claims that this whole connection turns around the Analogies of experience, as principles regarding the «existence» of objects, and thus that – to make the example that we have discussed above – the full instantiation of the metaphysical

(qualitative) concept of the conflict of realities only occurs in the “Mechanics” chapter with the treatment of material substance and interaction. But this reading does not appear completely convincing as a solution of our second, metaphysical problem: for the «concrete examples» corresponding to the conflict of realities here would be «velocity and quantity of matter» (p. 574), and these concepts still postulate the empirical representation of bodies (or matter in any state of aggregation) endowed with moving forces, which should be the very example *in concreto* for the exhibition of the conflict of realities.

According to Friedman, his reading preserves the separation of pure from empirical principles (pp. 575): while the metaphysical principles merely regard the «highest empirical concept in natural science» (p. 579), i.e. the concept of matter, the concepts of special moving forces, ether and states of aggregation are considered by Kant as issues of empirical physics and as such reviewed in the “General Note to the Dynamics”. Yet – in light of the doubts formulated above – it is striking that Kant would put into question precisely the concept of special moving forces, ether and states of aggregation in his new investigation of the a priori conditions of empirical physics in the *Opus postumum*. Given the subtlety and richness of Friedman’s new account of the MFNS, it would have been interesting to also find a deeper reassessment of this systematic connection with later writings, which is a crucial point in the literature.

A connected, minor remark regards the relation of Kant’ dynamical theory of matter to fluid dynamics. According to Friedman Kant is «following Euler» (p. 258) with his choice of a phenomenological model of matter, alternative to mechanistic atomism (p. 254). Friedman takes Kant to adopt this description «without either endorsing or rejecting any deeper explanatory models that may or may not later be discovered». This is a subtle way to connect Kant’s thesis of the original continuity of matter to empirical physics, but it slightly downplays the metaphysical motivation behind Kant’s new theory of matter. For it presents as a mere choice of “phenomenological models” – unable as such to exclude atomism – what appears to be a metaphysical *necessity* to Kant: that is, to endorse a view of matter as originally continuous – contrary to physical monadology and atomism – and then to *exclude* any physical theory (present of future) which does not explain material substance and its essential properties in a purely dynamical way.

As the above reconstruction (including my two remarks) suggests, Friedman focuses on the physical side of Kant’ arguments in order to make sense of his new metaphysics. As a final remark I suggest that with this focus – which is in itself completely right and fruitful – he leaves relatively in the margin Kant’s original problem of developing a new method of metaphysics. In different places he very subtly observes that Kant operates with «nested» sets of concepts corresponding to respective categories and to the latter’s instantiation in the metaphysics of bodily nature: for example, quality (category) corresponds first to impenetrability (as a merely empirical concept) and then to the filling of space (as a metaphysical principle, which grounds the possibility of mathematical constructions). Analogously Kant distinguishes substance from different concepts of

quantity of matter (pp. 183-184). In the “Conclusions” Friedman generally recognizes – as we have seen – that Kant connects the categories and principles of the understanding with «the empirical concept of matter» as the «highest empirical concept in natural science» (p. 579). But nowhere in the text he addresses the question of how Kant, given the table of categories, justifies the *content* of this empirical concept as a basis for the new metaphysics and its metaphysical elaboration into a set of principles («motion, the filling of space, inertia and so on» (AA, 472). This problem is connected with the development of Kant's logic and metaphysics, and in particular with his critical connection to Lambert. The first project of a «metaphysics of natural science» had been developed in Kant's close intellectual relation with Lambert in the 1760s and eventually required the development of a methodological alternative to Lambert's combination of Locke's theory of the sensitive origin of fundamental concepts and formal logic. While different connections with Lambert are analysed in Friedman's book, this general methodological point – which is crucial for the general understanding of the MFNS – is not the object of a close examination.

In conclusion, Friedman's combination of wide epistemological perspective and historical scholarship results in an extraordinarily rigorous and stimulating attempt to make sense of Kant's intricate view of the connection between philosophy and natural science, which sets a new standard for every future analysis of this important topic. Indeed, the above critical remarks do not detect proper flaws in Friedman's analysis, but rather indicate missing elaborations and desirable integrations to this reconstruction.

