

Review of

J. Christiaan BOUDRI

What was Mechanical about Mechanics

The Concept of Force between Metaphysics
and Mechanics from Newton to Lagrange

Translated by Sen McGlinn

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xvi + 276 pp. **CDN\$ 174.65**

In this study J. Christiaan Boudri seeks to throw a new light on the great disputes about force in eighteenth century physics by situating them in the context of the metaphysical disputes then current. To this end he marks out a trajectory of conceptual development which begins with seventeenth century understandings of force as something quasi-substantial and ends with the late eighteenth century construal of force as expressing a structural relationship among spatiotemporal elements. Boudri argues that this development cannot be properly understood as the mere expunging of metaphysical elements from mechanics as the Newtonian natural philosophy became accepted and recast mathematically. He contends rather that the controversies over the true measure of force (1686-1743), the status of the principle of least action (1734-1781), and the Berlin prize essay competition on the foundations of force (1779), are inexplicable from a narrowly mechanical perspective, and involve an uneliminable metaphysical dimension. The book's title thus seems intended as an oblique criticism of Dijksterhuis' marginalization of metaphysics in his influential *The Mechanization of the World Picture*—at least, it would if it were followed by a question mark; as it stands it gives a misleading picture of the book's contents. The subtitle remedies this, if a little awkwardly, ("the concept of force between metaphysics and mechanics"), which alludes to the book's treating the development of the concept of force as occurring neither within pure mechanics nor within metaphysics, but in the middle-ground between them.

Boudri begins with an outline of his argument, together with a defence of the utility of this kind of study against the imagined objections of positivists and instrumentalists, and an outline of his own position on metaphysics. This consists in an historicized Kantianism (following Görland), according to which the "a priori" is interpreted as concerning possible ways of knowing reality, and "possible knowledge" as that which is "not in conflict with the accepted insights of a specific time and within a specific discipline" (p. 25). Metaphysics is then all such a priori understandings, whether explicit or merely implicit. Whatever one thinks of this exclusion of ontology, it seems to secure the author a certain insulation against positivist criticism, and does not obviously detract from his analyses.

The main strengths of the book are Boudri's sympathetic treatment of the evolution of Maupertuis' position on the principle of least action in interactive collaboration with Euler, and his subsequent reconstruction of Lagrange's evolving thought on the status of the

same principle. In these pages, as well as in his analyses of the essays for the Berlin prize, Boudri succeeds in his stated goal of showing how considerations of metaphysics—and in Lagrange's case especially, implicit metaphysics—are crucial to a proper understanding of the natural philosophy of the period.

There is, however, a somewhat dated feel to the argument. This can perhaps be attributed in part to the shifts in the understanding of the history of science that have occurred during the book's long gestation, with the result that, in the wake of Burtt, Kuhn, Lakatos and others, the importance of metaphysics in the history of science is nowadays largely unquestioned. But there are also many recent studies in the field missing from the bibliography which one might have expected to find there, especially on the seventeenth century, such as those listed below. In particular, Boudri's discussion would have been substantially deepened by a study of the treatments of force in relation to the mathematics of the infinitely small by François de Gandt, Bertoloni Meli, and Michel Blay. The work of Stephen Gaukroger and others might have convinced him that for Descartes, as for Beeckman (whom Boudri does not discuss), a body in motion does possess a force—its inclination to remain in the same state of motion—whose measure depends on speed and bulk; and that an equal and opposite force is required for it to cease its motion. Thus the concepts of impetus (force of continuance) and resistance (equal and opposite to force of motion; effected by discrete impacts) are already unified prior to Newton (contra Boudri, p. 58), so that Newton's ground-breaking advances are therefore correspondingly more subtle, and closely related to his advances in mathematics. (Incidentally, this also explains why Leibniz's reading of the conservation of quantity of motion as conservation of *force* was not opposed by the Cartesians (p. 75)). Again, a reading of Michel Fichant's book might have convinced Boudri that much of what he characterizes as later developments in Leibniz's dynamics in response to criticisms (p. 81 ff.) were part of its early internal development after his discovery of the conservation of mv^2 in 1678, especially the idea of the conservation of force in each individual substance. Likewise, Leibniz's central dynamical notion of conatus as a force seeking change, derived from Hobbes and Weigel, is present in his earliest work (1671), and is not a later "extension of the concept of moving force" (p. 83). Finally, Bertoloni Meli's work is essential for a deep understanding of the dispute between Newton and Leibniz over force.

Still it must be stressed that the primary focus of Boudri's book is on the concept of force in the mid-to-late eighteenth century, and the above criticisms are only made relevant by Boudri's commendable effort to shed light on this through a proper attention to its historical genesis. In this respect the book is largely successful, and it is particularly to be recommended to those who still remain skeptical that metaphysics could have made anything other than a negative contribution of to the development of mechanics.

References

Blay, Michel. *Reasoning with the Infinite: From the Closed World to the Mathematical Universe*. Chicago and London: University of Chicago Press, 1998

Bertoloni Meli, Domenico. *Equivalence and priority: Newton versus Leibniz*. Oxford : Clarendon Press ; New York : Oxford University Press, 1993.

De Gandt, François. *Force and Geometry in Newton's Principia*. Princeton: Princeton University Press, 1995.

Gaukroger, Stephen. *Descartes: An Intellectual Biography*. Oxford: Clarendon, 1995.

Fichant, Michel. *La réforme de la dynamique : De corporum concursu (1678) et autres textes inédits*, Paris, J. Vrin, 1994.

Errata

pp. 33, 61, 147-149 in formulas such as $F = m \times a$ the multiplication sign \times would be better omitted

p. 36 Celsius, not Celcius

p. 42 state in, not statein; inability, not inabality

p. 45 resistance, not resitance; PROPOSIZIONE, not PROPOZIONE

p. 65 'Newton's reason for deducing', not 'Newton's reason to deduce'

p. 71 popularizer, not populisor

p. 88 âme, not ame (twice)

p. 121, 122 'indefinite', not 'undefined' as a translation of the Cartesian 'indéfini'

p. 125 Koyré should be cited in the original, not via Dijksterhuis

p. 141 'light exists in the air', not 'light consists of air', as a translation of 'la lumière existe dans l'air'

p. 154 delete one of the 2 periods at the end of the first new paragraph

p. 158 'mised', not 'mislead'

p. 161 —which ..., not —hich...

p. 163 'made him deny', not 'made him to deny'

p. 181 'the way it is acted upon by another force', not '...suffers from...'

p. 194 'illustrates the confusion', not 'illustrates of the confusion'

p. 197 'Newton's three laws of motion and his law of gravitation', not 'the three laws of Newton and gravitation'

p. 199 impetus, not impeto

p. 200 □M□nuds, not □M□muds