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Kant and the nature of matter: Mechanics, chemistry, and the life sciences

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ABSTRACT

Kant believed that the ultimate processes that regulate the behavior of material bodies can be characterized exclusively in terms of mechanics. In 1790, turning his attention to the life sciences, he raised a potential problem for his mechanically-based account, namely that many of the operations described in the life sciences seemed to operate teleologically. He argued that the life sciences do indeed require us to think in teleological terms, but that this is a fact about us, not about the processes themselves. Nevertheless, even were we to concede his account of the life sciences, this would not secure the credentials of mechanics as a general theory of matter. Hardly any material properties studied in the second half of the eighteenth century were, or could have been, conceived in mechanical terms. Kant's concern with teleology is tangential to the problems facing a general matter theory grounded in mechanics, for the most pressing issues have nothing to do with teleology. They derive rather from a lack of any connection between mechanical forces and material properties. This is evident in chemistry, which Kant dismisses as being unscientific on the grounds that it cannot be formulated in mechanical terms.

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1. Introduction

Throughout his career, Kant believed that the ultimate processes that regulate the behavior of material bodies can be characterized exclusively in terms of mechanics: that all we need for a general matter theory is mechanics. Modern commentators have been surprisingly accommodating on this, giving the impression that, whatever problems there may be at the level of detail, the programme itself was not a contentious one in the eighteenth century.[1]

Kant's mechanist programme can be summarized along the following lines. The core idea is that he is in a tradition that stretches back to Newton's *Principia*, which is taken as the model for scientific enquiry. The *Principia* is a work that unified celestial and terrestrial mechanics, and it rested on a general conception of mechanics as a precise quantitative means of exploring the physical behavior of bodies. The development of new mathematical resources rendered it much more powerful in the first half of the eighteenth century: the Bernoullis, Clairaut, and d'Alembert were able to solve basic problems through new analytical techniques. By mid-century a comprehensive mechanics was developed in the hands of d'Alembert, Euler, and others. This was rational mechanics, and it was deemed to have two distinctive features. First, it was an exclusively mathematical and a priori enterprise. The defining features of matter, for Euler for example, were its occupation of space, its impenetrability, and its inertia. Each of these could be established, on purely a priori grounds, as the fundamental characteristics of matter from which all other properties derived. Euler was then able to show how, using progressively more sophisticated mathematical resources, one could build up a general mechanics, moving from mass points, to rigid bodies, to flexible bodies, to elastic bodies, to fluids. The second distinctive claim of rational mechanics was the assumption that one should in time be able to move out from the core to other areas of 'physics', such as chemistry and electricity, thereby unifying all physical phenomena.

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[1] There are detailed discussions of Kant's accounts of scientific matters in Friedman (1992, 2003); see also Watkins (2001).

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In sum, Kant believed that he was following a well-established mechanical tradition, seeking to refine it in crucial respects.[2]

In 1790, in the second part of the *Critique of Judgement*, Kant raises the case of the life sciences, which seem to fall outside the purview of mechanical explanation. The context in which he raises this is matter theory, and his target is an understanding of the matter of living things as active. He associates living matter above all with Herder, but it has a longer history, which first came to a head with Tremblay's reports of the reproductive behavior of the freshwater polyp in 1744.[3] The idea of a whole animal regenerating from a slice removed from the original raised the question of whether matter could be said to be living. It suggested that life was not a property of organized beings such as animals, but of the matter from which they were constituted, for what else was there in the slices of the polyp? If matter could regenerate into a living organism, the conclusion drawn was that matter itself could harbor life. It was reflection on the behavior of the polyp that led Johann Friedrich Blumenbach, one of the most celebrated anatomists of his time, to argue that there must be an inborn active drive (*Trieb*) in all living things, which dictates their form, preserves it, and where possible repairs the organism accordingly if it is damaged. This active force is quite different from other forces and Blumenbach argues that reproduction, nourishment, and restoration of parts are all just modifications of one and the same force, which he calls *Bildungstrieb*, a formative or life force.[4] *Bildungstrieb* regulates the structure of the organism by mediating between an external stimulus and a capacity to activate the corresponding organs.[5] Once it has played this role successfully, however, purely mechanical processes take over the specialized functional tasks. *Bildungstrieb* is not a vital force simply supervening on material processes as it has no existence independent of material processes, but nor can it be reduced to these processes.

Both Kant and Herder were indebted to the idea of *Bildungstrieb*, but they interpreted it differently. Kant focused on mechanical causes within the organism, taking organization—in the form of *Bildungstrieb*—as given, whereas Herder focused on the active agency itself.[6] Kant treats Herder's advocacy of active matter in terms of allowing goal-directedness into the behavior of matter, into its very essence. Kant rejects this, arguing that the behavior of everything in the natural realm is mechanical, but that living things also need to be accounted for in terms of final causes, which means offering teleological explanations. He sets out to show that the need for teleological explanations tells us something about us, however, something about how we make sense of the world, not something about the world: we need to remove any element of teleology from matter itself, and to account for it instead in terms of how we perceive and make sense of particular kinds of activity.[7]

The alternative, which Kant associates with Herder, is what he characterizes as hylozoism, and hylozoism figures as one of the four basic categories of matter that he identifies.[8] These categories come in pairs, and the first pair works on the basis that 'all purposiveness in nature is unintentional'. It comprises two options: 'lifeless matter', where a mechanical causality is all that is involved, and 'a lifeless God', a position he associates with Spinoza. The second pair of alternatives by contrast works on the basis that 'some purposiveness in nature (in organized beings) is intentional.' One option asserts the existence of a living (as opposed to a merely Spinozean) God, but this is 'incapable of dogmatically establishing the possibility of natural ends as the key to teleology.' The other option is hylozoism. This is rejected on the grounds that

> even the most daring hypothesis can be authorized only if at least the *possibility* of that which is assumed to be its ground is *certain*, and one must be able to ensure the objective reality of its concept. However, the possibility of a living matter (the concept of which contains a contradiction, because lifelessness, *inertia*, constitutes its essential characteristic), cannot even be conceived; the possibility of an animated matter and of the whole of nature as an animal can be used at all only insofar as it is revealed to us (for the sake of an hypothesis of purposiveness in nature at large), in experience, in the organization of nature in the small, but its possibility can by no means be understood a priori.[9]

What is the basis for Kant's claim here? Is it simply that anything at variance with a mechanical conception of matter is not viable as a (complete) physical explanation?

2. Mechanism and matter

Kant advocates an exclusively mechanical construal of physical processes, including the material properties of bodies, and we need to ask what might have motivated this approach. As I have indicated, Kant himself clearly thought that he was working in the Newtonian tradition that had revolutionized our understanding of terrestrial and celestial mechanics. But Newton did not take mechanics as a general model for matter theory. In his early work on optical refraction Newton discovered that in order to account for the fact that sunlight that is refracted through prisms forms a lozenge-shaped image, not a circular one, he had to suspend his commitment to corpuscularian micro-reductionism as the sole form of explanation, just as Boyle, in struggling to account for the 'spring of the air' had done before him.[10] And when it came to the various material phenomena that Newton struggled with throughout his career, such as fermentation, vegetable growth, pressure, gravitation, aether, electrical attraction, and the radiation of light, he abandoned mechanical explanations at an early stage.[11] The model for Kant's approach comes not from Newton, but from a particular subsequent development of the *Principia*, particularly in France, which tries to build a more general project out of it, something that Newton himself never attempted. This is rational mechanics, epitomized in the work of Euler. Its practitioners conceived it as a model of physical enquiry, and their hope was that once the mechanical core had been developed and firmly established, one could work outwards to areas such as gravity, chemistry, electricity, and optics, reducing them to an axiomatically-structured mechanics, and reworking them into a systematic form. But the mathematical sophistication of rational mechanics was not mirrored in its physical relevance, and it became effectively insulated from the main body of physical sciences, which were the successors to the seventeenth-century 'experimental natural philosophy' tradition, and, in areas like chemistry and electricity, were concerned largely with making sense of a mass of complicated experimental results. Rational mechanics could provide no guidance at all here, any more than could micro-corpuscularianism. In consequence, it became distanced from what were the cutting-edge developments in the sciences.

[2] This is the standard approach to Kant in the literature: an example is Kerzsberg (2006).
[3] Tremblay (1744).
[4] Blumenbach (1789).
[5] Blumenbach (1797), p. 12.
[6] Richards (2002), pp. 216-37.
[7] See Kant (2000) pp. 235-55.
[8] Kant (2000) pp. 262-6.
[9] Kant (2000) pp. 265.
[10] See Gaukroger (2006), pp. 352-99.
[11] See Dobbs (1991).