

JAAP VAN BRAKEL, *Philosophy of Chemistry. Between the Manifest and the Scientific Image*, Leuven University Press, Leuven, 2000, xvi +246 pp. (ISBN 90-5867-063-5).

This is a very welcome and indeed unique book. For the first time a full scale, serious study has been attempted of chemistry as a distinctive and irreducible scientific discipline. The value of a book like this lies not only in the work herein reported but also in its role as defining the topics that are proper to the field. Many of us have dabbled here and there in issues unique to chemistry, but this is the first major effort to survey what a philosophy of chemistry might encompass. Furthermore, van Brakel has entered into the issues, and has identified as himself a player. This is, therefore, not only a survey, but also a debate. As a philosopher reviewing this book, I am invited to take issue with the author here and there.

The first chapter is a historical survey of what little there has been published in this field. Van Brakel offers two historiographical theses to account for the way that philosophy of physics has been the dominant partner in the philosophical study of the exact sciences. Roughly these are:

1. That of the basic Aristotelian pair, form rather than matter became the predominant interest of philosophers of science.
2. The generic properties of matter rather than the distinguishing properties of substances became the focus of attention.

I am not sure how far I agree with this diagnosis. At least in the seventeenth and eighteenth centuries the question of the nature of qualities was a major philosophical preoccupation. Boyle's famous book, *On the Nature of Forms and Qualities*, is one of the great classics of the philosophy of chemistry. Locke's careful development of the concepts of real and nominal essences of substances (not of 'substance in general') became a

permanent part of the philosophical armory. Indeed, Kripke probably picked it up in 1961, when as a graduate student in Oxford, he attended a university class on the philosophy of chemistry in which Locke's famous distinction was discussed in both its historical and its contemporary applications. Whewell's great *The Philosophy of the Inductive Sciences*, published in various forms from about 1830, is dominated by the ontology of chemistry. Yet, van Brakel does not mention it. What is certainly true is that in the period dominated by logicism in the philosophy of science, say 1850 to 1950, an attenuated philosophers' version of physics became the prime topic of analysis for those interested in the philosophy of science.

Despite these omissions, the chapter is full of insights and interesting material. The discussion of the significance of Kant's famous aphorism reducing chemistry to a practical art is particularly valuable. The most interesting is a detailed exposition of the chauvinistic debates in Eastern Europe about the status of the 'resonance' theory of the benzene ring. Resonance is a metaphor for a kind of averaging of the distribution of single and double bonds between the constituent carbon atoms of the benzene ring. The Russians tried to develop a 'Marxist' theory, accusing Pauling, the originator of the 'resonance' metaphor of 'idealism'. Chauvinism appeared again in the futile priority issue between (Russian) advocates for Bulterov and (German) promoters of Kekulé as the inventor of structural organic chemistry.

The philosophical question of the viability of the concept of a natural kind is surely the most important in philosophy of chemistry. Van Brakel has two shots at it. In Chapter 2, he picks up the somewhat outdated idea of a contrast between a manifest image of the world and a scientific image. I believe he concedes far too much to the neopositivism of hard-line empiricists like van Fraassen, whose work is richer in aphorisms than arguments. Sellar's arguments for the priority of the scientific

image are not deeply rooted in the physical sciences. Witness the lack of attention in this chapter to the key role of activity concepts like causal powers and affordances in the physical sciences. The chapter ends with a dilemma. Either we must countenance a plurality of natural kinds depending on the 'grammar' of the discourse genre in use in a domain, (this seems to me the right answer) or we must abandon the idea of natural kinds altogether. However, this, it seems to me, would be to abandon *chemistry*. If the project of van Brakel's book is to succeed, there must be a science of chemistry which is not just physics. So, the horn of the dilemma that would delete chemistry from that status must be rejected as the root of a *reductio ad absurdum*.

The author's second approach to the natural kinds issue is built around the attempts by Putnam and Kripke to establish a version of the nominal essence/real essence distinction as a theory of the meaning of kind terms. Van Brakel seems to favor the skeptical conclusion on this issue: namely, that there are no natural kinds. His argument turns on the context dependence of the choice of properties that are to be incorporated into the criteria for the application of kind terms. Not only are these choices relative to context (criteria for the use of the word 'gold' in the Yukon in the nineteenth century, and criteria for the use of the word in Aston's laboratory, are not the same, for example) but also they are historically dependent on the state of chemical theory. Again, thanks to the comprehensive presentation of the arguments, one can enter into the debate fruitfully. It seems to me that without the formal pattern *nominal essence/real essence*, there would be no chemistry. The question is not whether this pattern makes sense, but how, in particular moments in the history of chemistry, it is filled out. Contexts and epochs may see considerable changes in the content while the form is stable over millennia.

I was happy to see a very thorough exposition of the neo-realist analysis of science developed mostly in the UK, based on two important theses.

1. Laws of nature are descriptions of (mostly) iconic models, to which they are internally related (pp. 157–159).
2. The real world, as it must be conceived for science to be possible, is a pattern of capacities, powers and affordances.

Cartwright has argued, convincingly, that acceptance of thesis 1 entails the acceptance of thesis 2. While noticing this point van Brakel does not, perhaps, give it the significance it deserves.

This raises another issue: how far has chemistry depended on agency concepts? Classical chemistry covered two distinct kinds of processes inducing substantial change. Some required active human intervention. (Boyle called this 'boiling and coction'.) Some required only the juxtaposition of substances, such as sulfuric acid and metallic zinc. A reaction began without further intervention. As a student, I learned the ECS table, ranking substances according their relative powers to displace one another from compounds. Is this basic distinction still needed? If it has been superseded, how has it been?

On the question of the reduction of chemistry to physics, I am not entirely clear as to van Brakel's position in Chapter Five. At first reading I thought he would reach the sort of conclusion drawn by Polanyi when discussing this issue in the 1950s: namely, that chemistry requires boundary conditions that are not derivable from physics. In short, structure is an irreducible aspect of molecules that cannot be derived from quantum mechanical considerations. After a thorough survey of the arguments, van Brakel seems to finish up as an agnostic.

To sum up: this is an excellent book. It is based on a massive survey of the literature, done in such a way that the tie between philosophy in general, philosophy of science, and chemistry itself is managed convincingly. The author is

bold enough to take positions himself on various controversial matters, inviting us to argue with him. This is just what a good philosophy book should do! If anyone doubted that there is a philosophy of chemistry, full of interesting issues, this book should convince the skeptic.

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