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Shifting paradigms in chemistry**Maurice Crosland***Chemistry Transformed: The Paradigmatic Shift from Phlogiston to Oxygen.* By H. Gilman McCann. Pp. 179. (Ablex: Norwood, New Jersey, 1978.) \$14.95.

THIS book is in many ways a pioneering study. Using T. S. Kuhn's idea of 'scientific revolutions' Dr McCann has spent more than ten years analysing one particular case. It is comparatively easy for the non-specialist to understand the main features of the so-called 'Chemical Revolution' of the eighteenth century, and a succession of philosophers of science have used it to illustrate their views about theories, falsification, and so on. This is the first time that a sociologist of science has tackled this historical question and we must respect the author's study of the relevant chemical journals and a wide range of secondary literature. This is no superficial survey but an attempt to achieve a better understanding of what really happened. The author also touches on the beginnings of the professionalisation of chemistry in France. With his great industry in statistical analysis of his data McCann deserves to succeed in saying something new and important. Certainly his approach opens up several interesting perspectives.

It is difficult to say exactly when Lavoisier's oxygen theory came to take the place of phlogiston. McCann marshals his data into periods: 1772-77 being the period during which Lavoisier was developing his theory and 1778-84 the years when Lavoisier was trying to justify his theory to others and meet their objections. 1785 was the year of Lavoisier's experiment on the composition of water which helped win over Berthollet, with other major chemists soon to follow. In Britain conversion to the new views was slower, and much ingenuity is exercised by the author to explain this. Rejecting nationalism as a possible ground, McCann believes that the British "chemical community" (if there was one) was more elderly than the French and therefore more conservative. Indeed the importance of age is claimed to be one of the great 'discoveries' of the quantitative sociological analysis used. But the author passes far too

easily from a plausible hypothesis about receptivity to one about innovation. It is claimed that what made Lavoisier unique was not (as has been assumed) his genius but his comparative youth, being only 29 at the time of his vital work which recognised the gain in weight of phosphorus on combustion. But what about other French chemists who were about the same age? One might mention the provincial chemists Cornette (28) or Opoix (27). Of course these did not have the advantage of living in Paris, of being members of the Academy, or of having a special interest in gases. But if age was so important in being open to change why is Lavoisier's exact contemporary Opoix remembered (if at all) as a late champion of the phlogiston theory?

Perhaps after all one needs to examine various other factors including

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Antoine Lavoisier

the arguments used on both sides, an aspect glossed over in the sociological treatment. The superiority of the oxygen theory is assumed and it is never mentioned that this 'correct' theory whose acceptance we are analysing included the (incorrect) 'caloric'. This is particularly serious in so far as it affects the very concept of a 'paradigm shift' mentioned in the subtitle, as it has been suggested that in some ways 'caloric' was phlogiston under another name. On p96 there is a remark about "the period of crisis as the French chemists solved problems that stymied the phlogistonists of Britain" but there is no hint that the phlogistonists provided problems such as that of 'heavy inflammable air' which were insoluble in terms of the oxygen theory until Cruickshank in 1801 showed that this was carbon monoxide.

The attempt to gain new knowledge

by a quantitative approach is worth serious examination and it is a pity that this brave beginning is open to a wide range of objections, of which one is the small size of the sample used. Thus in the period 1778–80 one new author could write 20% of the articles cited. The problem of the disproportionate number of articles written by Lavoisier himself is fully appreciated by the author, who presents data in alternative forms to meet this objection. There is also the problem of biographical detail for some of the lesser well known chemists which might affect the picture of the 'average chemist'. Finally it is

not clear to the reviewer how we can count "oxygen articles" in journals before the discovery of oxygen.

I am sure that a careful use of a quantitative approach may provide valuable new insights in understanding the development of science but it will be all the more useful if it is brought in as an additional tool rather than as an alternative. In counting heads let us not ignore what was in those heads.

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Respecting aberrant figures

J. R. Ravetz

Man and Nature in the Renaissance. By A. G. Debus. Pp. 159. (Cambridge University Press: Cambridge and London, 1978.) Hardback £7.95; paperback £2.50.

THE history of the science of the period of the Renaissance is directly relevant to the practice of science today, for our present ideas of what constitutes genuine science, and what demarcates it from false imitations, were forged then. For a very long time it had been common for historians to take the evaluations of the seventeenth-century innovators as simple fact: those who adhered to older methodologies of world-views were simply reactionaries, fools or charlatans. Scientists who achieved great science (by our standards) in spite of such defects (as Kepler or Gilbert) were explained as being "strange mixtures of the old and the new".

In recent decades, there has been a thin but growing stream of research

that treats some of the aberrant figures with respect, both for their stature in their own times and for such 'positive' achievements as can be gleaned from their work. The most promising candidates for such re-evaluation are in the tradition of alchemically tinged practical chemistry, relating directly to metallurgy, medicine, and having implications for philosophy, religion and politics. The leading figures in that 'chemical philosophy' were Paracelsus and van Helmont; its leading interpreters Page, Rattansi and Debus.

Now this school has produced an introductory textbook by which students are shown how much more there was to the scientific revolution than the developments centring on the work of Galileo. In it we find brief and illuminating accounts of the 'chemical philosophy'. Otherwise, it is a competent survey of developments in science and in methods in the sixteenth and early seventeenth centuries. As it is read and used, we may expect that the 'chemical philosophy' will achieve a sort of respectability among those who learn or teach the history of science.

This is a very valuable achievement. A most urgent educational task is to show that the Galilean style of reductionist, abstracted research is not the uniquely true approach to a proper knowledge and control of nature. A modest and uncontroversial introduction to a broader conception of science

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will have a greater diffusion in teaching establishments than a strident polemical tract. But a price is paid for this very Fabian approach to intellectual reform; there is a loss, not so much of ideological militancy as of historical drama. Our sort of science was conceived and propagated by men with a prophetic mission. The issues in their debates ranged over all human values and experience. Different conceptions of reality were in open collision then, and ideological commitments (based on a fusion of political and theological concerns) could be as important as experimental facts in determining positions in the still immature natural sciences of the time. Of all this, we get only the most mild of hints. The received historical doctrine of the rise of modern science as an automatic consequence of the adoption of correct attitudes and methods, is here not so much challenged as modified at the fringe. But perhaps that is appropriate for a pioneering venture in textbook writing; and as a simple, lucid and accessible introduction to its subject, the book succeeds well. □

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