designed to detect our motion through it. Accounting for these failures through such mechanisms as the Lorentz contraction entailed a great elaboration of the electrical theory of matter during the years 1890–1905.

Into the midst of this complexity, Einstein brought his theory with its two basic postulates: relativity is a universal condition (no preferred ether frame) and the speed of light is a universal invariant. From this simple beginning, all else followed — length contraction, time dilation, mass varying with speed and so on. Surely this brilliant solution should have been immediately acclaimed and universally accepted. But what actually happened? For a couple of years, except in Germany, it was almost totally ignored; thereafter it was widely resisted. In discussing why that was so, Goldberg considers the reception of the theory in four different cultures — German, French, British and American. In a brief review it is hard to do justice to Goldberg's analysis, but he suggests that Germany's academic tradition, and its strongly interlinked academic structure, encouraged active debate. By contrast, any French reaction may have been stifled by the extreme conservatism of that country's educational system — coupled with a lack of enthusiasm on the part of Poincaré, who himself came so close to inventing relativity. In Britain the love of mechanical models, and a suspicion of abstractions, made many distinguished physicists reluctant to abandon the ether. And in the United States the main obstacle was the conviction "that acceptable theories had to conform to acceptable notions of common sense", a precept which Einstein's theory clearly violated! Goldberg's identification of such national and cultural differences is interesting, although he himself dismisses any thought of a "party line" in such matters.

The last part of the book discusses the assimilation of relativity in the United States after 1912. Much of this deals with the question of whether the invariance of the speed of light is amenable to experimental test or is, as Einstein presented it, an untestable postulate. Goldberg concludes that, even today, many American physicists take the former view (which makes no difference, of course, to their acceptance and use of Einstein's equations).

All in all this is a rewarding book, whether or not one agrees with its particular theses and interpretations. For anyone who is not a scientist, it will provide a healthy (and intended) antidote to the view that the progress of science is impersonal and inevitable. And for the professional physicist, it offers a wealth of background to the history of special relativity as such. □

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Sulphur in movement

C.E. Rees

The Global Biogeochemical Sulphur Cycle.
Edited by M.V. Ivanov and J.R. Freney.
Wiley: 1984. Pp. 470. $79.95, £42.50.

SULPHUR is only a minor constituent ($\sim 260\,\mu g\, g^{-1}$) of the Earth's crust, much of the original complement of the element either being lost to space, along with other volatiles, during the accretion of the planet, or transported to the core during early differentiation. Nonetheless sulphur is important both geochemically and biologically. It is essential to life, because of its presence in the amino acids cysteine, cystine and methionine, and is crucial to modern man because of its use in the agricultural and chemical industries. Further, it is an unwanted constituent of fossil fuels and is being released into the environment at an increasing rate with consequences which are receiving increasing publicity.

The chemistry of crustal sulphur is a complex matter, both because of the different oxidation states in which the element can exist and because of its involvement in a wide variety of biological and geological processes. The major crustal reservoirs are sulphate dissolved in the oceans, sulphate stored as evaporitic minerals and reduced forms of sulphur in sediments. Cycling occurs through these reservoirs on a rather long time-scale ($\sim 10^7$ yr) by three main processes: bacterial reduction of ocean sulphate to form sedimentary sulphides; the formation of evaporitic sulphate minerals; and the return of sulphate to the oceans by erosional processes. Other small, though still important, reservoirs of sulphur include fresh water, the atmosphere and the biosphere (of which the sulphate-reducing bacteria form only a small and rather odd part).

The Global Biogeochemical Sulphur Cycle is an attempt, and in my view a highly successful one, to summarize what is known about the geological and biological reservoirs of crustal sulphur and how the element is cycled between them. The natural (or pre-industrial) sulphur cycle receives most attention, but where possible information is given concerning the perturbations of the natural cycle by the activities of man — sulphur is now being added to the oceans at perhaps twice the pre-industrial rate, and present-day emissions of sulphur to the atmosphere from the combustion of fossil fuels and ore smelting probably exceed natural emissions by a factor of two to three.

The book begins with a brief introductory essay — "Principal Reactions of the Global Biogeochemical Cycle of Sulphur" — after which individual chapters cover the sulphur cycle in the lithosphere, in soil, in the atmosphere, in continental reservoirs and in oceans. There is a final chapter which summarizes the information available on the major fluxes of sulphur within and between the various reservoirs. Of the eleven contributors to the book, nine are Soviet scientists. This is not a weakness because the coverage of the subject is clearly global in scope; indeed, it is valuable to have a summary in English of the wide Soviet literature on the subject.

Preparation of material for the book was essentially complete by 1979 when an international workshop was held in the USSR to offer comments on draft versions of the various chapters. Accordingly the literature cited is largely that published before 1980. The authors, editors and, where appropriate, translators, as well as the participants in the workshop, are to be congratulated on their production of a synthesis of data available up to that date which is exhaustive in its detail but well organized and clear in style. □

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Quality for quantity?

J.R. Ravetz

The Citation Process. By Blaise Cronin.
Taylor Graham, 500 Chesham House, 150 Regent Street, London W1R 5FA: 1984. Pp.103. Pbk £10.

THIS elegant little study takes its origin from a paradoxical aspect of the social activity of science — that the system of citation of previous research, performing several essential functions for that activity, has only very recently been appreciated as at all problematic. It is scarcely 15 years since critical analysis of the citation process began; and as the author shows, it is still very marginal, divided and incapable of offering much practical advice.

In principle, citations enable science to be truly "public knowledge" by providing techniques for checking on the sources of materials used in a paper but produced elsewhere. And they are the main regular means for the validation of the intellectual property embodied in a paper; the users of that property "pay" through the credit given to its author in the cited reference. In the idealistic image of science codified in the "four norms" of Robert K. Merton, there was no occasion for either of these functions to be other than straightforward. But with the rise of a critical, even demystifying sociology of science, it was discovered that the practice of citation was strongly subject to personal interpretation and also to political manipulation. When the *Science Citation Index* became available, providing what seemed to be an objective measure of quality of papers and of researchers, and was invoked in legal disputes over promotion and status, the quality-