examination, not least because the principles and processes of government form a substantial part of social science research. Social scientists, if they do their job properly, are likely to be a constant source of embarrassment to government. It requires some sophistication to realize that the general good can be enhanced by paying someone to embarrass you.

Studies of the relationship between social science and government and the formation of policies for the social sciences are still something of an infant industry. Indeed, this book is the first to look at such questions from a variety of different national perspectives. It consists of eleven papers presented at a conference held in Paris in April 1970, under the auspices of the International Social Science Council, together with an extended introduction by A. B. Cherns and an annotated selective bibliography.

The papers are grouped into three parts, reflecting the conference sessions, entitled "Social Science as a Policy Area", "Aspects of Social Science Policy", and "Social Scientists and the Making of Social Science Policy", respectively. In fact, any one of the eleven papers could have appeared under any one of the three headings without seriously disturbing the book's equilibrium. This comment is not intended as a criticism. It is a comment on the undeveloped state of social science policy as a field of study.

The individual papers are as variable in quality as one might expect them to be. There are, though, some notable high spots. Bertrand de Jouvenel follows a short and lucid treatment of the points of identity and difference between the natural and social sciences with a caution about the limitations of economic and social statistics. Statistics are a reflexion of past concerns and are of limited value in focusing our attention on the future.

Andrew Shonfield explores the way in which the theoretical consensus underlying economics has enabled economists to play a uniquely important part in the policy-making process, and anticipates the time when the development of a system of social indicators will allow non-economic factors to be given greater weight.

Many conference books suffer from minimal editing. By contrast, this one is edited with care and intelligence. In particular, the "Interchapters", which summarize the discussion after each paper, are models of coherence.

JEREMY MITCHELL

# Physical Sciences

## Aetherial Problems

*The Etherial Problem: a History of the Michelson-Morley-Miller Aether Drift Experiments, 1880–1930.* By Lloyd S. Swenson, Jr. Pp. xxi+361. (University of Texas: Austin and London, July 1972.) £4.75; $10.

WHILE reading this interesting, well-written, thoroughly documented book, I was also reading, collaterally, a book by a hippy about hippies. When I sat down to write this review, what came to my mind's eye was the greatest of them all, walking across the Princeton campus in worn leather jacket, his long white hair breeze-borne, flanked by his two assistants, Bargmann and Bergmann. For if ever a man cocked a snook at the establishment of theoretical physics, that man was Einstein. It was he who converted the then-burning issues treated in this book into dead meat for historians to pick at. In his own estimate, Professor Swenson is three parts historian to one part physicist, and the combination seems well suited to this job. He reconstructs with great skill and sympathy the personalities of his chief characters (Michelson, Morley and Miller). Michelson started as midshipman in the US Navy and was Master when he wrote his paper of 1881 entitled "The relative motion of the Earth and the Luminiferous ether." Swenson writes: "Michelson was a sailor, pilot, and navigator before he became a physicist. His greatest fame as a physicist stems from his efforts to solve certain kinds of relative-motion problems which he could not have avoided as a naval officer." The paper in question is reproduced in an appendix and I started to read it with the reverence due to an historical document. Can you believe it? This naval officer was apparently ignorant of the parallelogram of velocities, and his calculations err by a factor of two. In the more famous Michelson-Morley paper of 1887 this "oversight" was corrected, having been pointed out by Potier and Lorentz.

It is interesting to compare the dates of Michelson (1852–1931) with those of Edison (1847–1931). This was the great American age of what might be called, without disrespect, inspired gadgetry, and Michelson's interferometer was a brilliant example of such creative skill. The visible spectrum of physics (the invisible part lying in the subconscious) extends from accurate experimentation to the creation of new concepts, and it was in the former that Michelson, Morley and Miller excelled. Their concepts were basically the absolute space and time of Newton, associated with a mischievous aether which refused to behave consistently. The date (1905) of Einstein's famous paper neatly bisects the time-range of the aether-drift experiments described in this book, and one might expect relativity to have killed them off earlier. But we read of Einstein visiting Miller in 1921 and urging him to continue aether-drift trials and to re-examine the earlier results obtained in 1881, 1887 and 1902–1905. Perhaps it is not as simple as it seems. To teachers of physics I suggest as a healthy exercise the preparation of a lecture to explain, clearly and succinctly, how one can accept, consistently, both the null result of the Michelson-Morley experiment and the facts concerning stellar aberration, said lecture to be delivered, not to a herd of sheep, but to a class of intelligent undergraduates with a minimal respect for the authoritative word.

When I accosted relativity in 1920–21, that was one of the problems I found difficulty with, but I had the good fortune to attend the course of lectures by Silberstein in Toronto, mentioned in a footnote by Swenson (page 197); I must, however, correct a detail —Michelson was not there, to my knowledge. Silberstein not only lectured excellently, he explained things to me personally; nevertheless certain difficulties remained, notably with regard to rigid bodies. It took me many years to realize that all this talk about measuring rods is bunkum, as Michelson himself ought to have seen, since, in an interferometer, the things compared are not lengths, but optical paths, that is times.

According to evidence presented in this book, the Michelson-Morley experiment was not, as is sometimes supposed, "the primary cause and justification for Albert Einstein's first work on the theory of relativity." As for the small positive results reported by Miller in his aether-drift experiments, these are (in view of the elaborate analysis by R. S. Shankland *et al.*) to be dismissed as thermal effects.

There is a bibliography of fifty-seven pages, appendices reproducing papers by Michelson and Morley, and a good index. Footnotes are where they should be, at the bottom of the pages.

J. L. SYNGE