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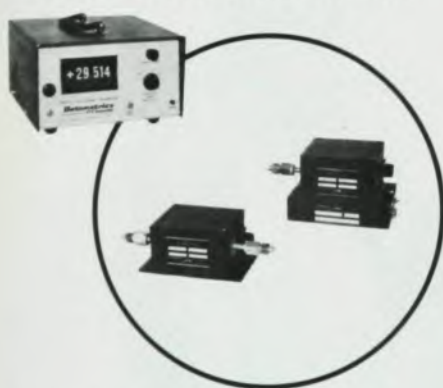
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ment of strict determinism. Considerable controversy has been aroused by this view. Authorities like Niels Bohr, Max Born and Werner Heisenberg have (along with most physicists who use quantum mechanics in their researches) ranged themselves on the statistical side, whereas equally great celebrities like Albert Einstein, Erwin Schrödinger and Louis de Broglie have defended the deterministic viewpoint. This controversy is the theme of *Are Quanta Real?* whose author, Josef M. Jauch, a well-known authority on quantum mechanics, is Professor and Director of the Institute of Theoretical Physics at the University of Geneva in Switzerland.

The author has chosen an ingenious and felicitous way of handling his theme. He has resurrected Galileo's famous dialogue plan used in the great works *Dialogues Concerning Two New Sciences* (1638) and *Dialogue Concerning the Two Chief World Systems—Ptolemaic and Copernican* (1632). So we once more have the pleasure of listening to Salviati, Sagredo and Simplicio, this time, after a lapse of nearly three and a half centuries, arguing about the reality of quanta. As before, Salviati represents largely the author of the book, while Sagredo is the eager questioner with an open mind. Simplicio comes off somewhat better than his illustrious 17th-century predecessor, for though a sceptic he is by no means ignorant and indeed has a thorough grasp of quantum mechanics, though he does defend the deterministic point of view and does it well. But so far as the reviewer can make out, the "virtue" that triumphs at the end of the fourth day of discussions is the statistical interpretation, which is argued by the author rather persuasively. The reader of the book will, of course, wish to judge for himself and he will certainly be challenged by this clever, thoughtful and entertaining presentation of the problem.

* * *

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Ernst Mach: His Life, Work and Influence

John T. Blackmore

414 pp. U. of California Press,
Berkeley, 1972. \$16.95

The history of 19th- and 20th-century philosophy of science has for too long remained unwritten. Although it is indisputable that many scientists of

the time were influenced in one way or another by contemporary philosophy, until recently we have had no intensive studies of the lives and influence of such important groups as the German positivists. Ernst Mach was among the most well known philosophers, at least among scientists, of the late 19th century. Though he thought of himself as a physicist, much of his writing centered on what he believed to be the proper foundations and methods of science, and many scientists of the time, including Max Planck, Ludwig Boltzmann, Wilhelm von Ostwald and Albert Einstein, were influenced by or engaged in polemics with Mach. There is a very definite need for a book detailing Mach's life, his philosophical and scientific work, and his influence.

John Blackmore, who teaches the history of ideas at Harvey Mudd College in California, wrote his dissertation on Mach, and this book is a revision of it, a revision that involved cutting the doctorate in half. Perhaps this drastic editing is the source of the book's failings, for Blackmore's work is most inadequate. Blackmore tells us in his preface that he wanted to produce a true biography, to show and explain Mach's philosophical and scientific ideas, and to emphasize his influence on 20th-century science and philosophy of science. This is a large task, which requires a perceptive look into the man's life and into how his work was affected by his personal affairs. The author needs as well the ability to separate the various aspects of his subject's philosophical career, to tell us what they were and how they came to be. He must have a keen sense of the history of the time and how science developed in it to be able to show his readers where his subject's work fits in and what influence it had.

Unfortunately Blackmore's *Ernst Mach* fails to fulfill the promises of its preface and proves inadequate either as an historical account or as an explanation of the issues involved. His treatment of Mach's personal life and the effect it had on his philosophy illustrates the inadequacies in Blackmore's appreciation of the ways in which incidents in a man's life can affect his work, for he gives us no real analysis of Mach's growing-up or a sense of the gradual, historical development of his thought. He merely lists events and asks us to believe that the elderly Mach correctly interpreted the effects certain of his youthful experiences had on him.

In spite of Blackmore's inadequacies as a biographer we might hope for a clear explanation of Mach's philosophy, at least in its mature form if not as it developed over time (the latter we surely do not get). Here again,

though, Blackmore fails. He seems to believe that philosophical terms and issues are well known to any reader; he often introduces a term in quotation marks and leaves it at that—as if quotation implied recognition. But are doctrines such as “representationalism,” “naive realism,” “presentationalism,” “causal realism,” and “phenomenalism” so universally understood that they do not require adequate explanation? I think not, yet Blackmore explains them at best superficially. Even those well versed in philosophy will be confused by his writing because he is idiosyncratic in his terminology.

We might have hoped that Mach's science, if not his philosophy, could have been presented with some historical sensitivity and have been properly explained. But here again Blackmore is unsuccessful. For example, in speaking on page 92 of Mach's treatment of Newtonian force he goes so far as to say that “In dynamic terms, Newton anticipated the qualitative aspects of Einstein's mass-energy law.” This is historical nonsense of the most blatant sort and indicates that Blackmore has little appreciation of the scientific thought of a period. We find the same sort of thing in his accounts of Mach's experimental work.

Even if he fails in recounting Mach's life, detailing his philosophy, and explaining his science, Blackmore could still have written something useful about the influence of Mach's philosophy on the era's scientists. He could have told us of the points at issue between Mach, Boltzmann, and Planck on the reality of atoms, and between Mach and Einstein on relativity, but we get only a long account of meetings and many quotations from letters. More unfortunate even than this lack of explanation is the intrusion into the story of Blackmore's own prejudices; he does not, for example, like Einstein's general theory of relativity and writes on page 256 that “common sense” objects to Einstein's “curious opinion that gravitational acceleration is more understandable than inertial acceleration and that geometry is capable of explaining inertial acceleration.” Perhaps Blackmore's “common sense” objects, but then Leibniz's “common sense” objected to Newton's forces acting at a distance. Blackmore often reverts to his notion of what “common sense” has to tell us, but as any historian of science knows, what is “common sense” in one period is arrant nonsense in another.

I cannot recommend this book to anyone who has not a full knowledge of 19th- and 20th-century physics and philosophy of science. The untutored—and even the tutored—reader will only be confused by Blackmore's turgid style and random organization. He



MACH

will learn little of Mach's life, philosophy, or science that he will find illuminating, and much of what he does learn will be at best inadequate, and often simply incorrect. Perhaps Blackmore's dissertation covered the subject more properly, but his book is a jumble of ill-conceived ideas and poor history.

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Group Theory and the Coulomb Problem

M. H. Englefield

120 pp. Wiley, New York,
1972. \$11.95

The Kepler or Coulomb problem has had a never ending fascination for the physicist and mathematician, from the time of Kepler to the present. It has many faces and much beauty as a

physical theory, and, at the same time, it represents the only truly realized isolated two-body problem occurring in nature. It appears in gravitational and electromagnetic interactions (where the accuracy with which the $1/r$ potential is measured is truly staggering), and perhaps also inside the proton, the foremost and simplest hadronic system. It is this latter empirical aspect that really justifies efforts in discovering new forms, new faces and new symmetries of an old problem. Perhaps a deeper reason for the special role and symmetries of the $1/r$ potential and its exact solubility is that only in this case is the potential a solution of the Laplace equation with a point source at the origin.

The group-representation theory entered into the theory of the Kepler problem in the early days of quantum mechanics, when Wolfgang Pauli first solved the H-atom problem by matrix mechanics in 1926. The group structure of the levels of the atom for fixed energy was subsequently exhibited explicitly by V. Fock, L. Hulthén and V. Bargmann, and turns out to be the four