

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.

JED Z. BUCHWALD

*Department of the History of Science
Harvard University*

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

dimensional rotation group $SO(4)$ rather than the geometrical symmetry group $SO(3)$. In 1964 we again see references to these early papers appearing, this time in connection with the group structure of all levels of the atom, not just those for fixed energy, including even the continuum. The new time-dependent symmetry operators together with the previous time-independent symmetry operators generate the conformal group whose single irreducible representation now describes all levels and degeneracies of the atom. Such generalized symmetry groups have been called "dynamical groups."

Englefield's book is an introduction to these recent developments on which there exists considerable literature and activity in view of similar models in particle and high-energy physics. The author addresses himself to an audience with a knowledge of the quantum theory of angular momentum only, but not necessarily more group theory beyond this. After a brief initial review of Lie algebras and the theory of angular momentum he develops explicitly some representations of the simplest noncompact groups like $O(2,1)$ or $SU(1,1)$ and $O(3,2)$. These are the prototypes and building blocks of other noncompact groups. The calculations are explicit. One feels, however, that more knowledge of modern group-rep-

resentation theory would make the description of the subject matter more compact and elegant. In fact the representation theory of noncompact groups enters more and more into many areas of theoretical physics. This is not surprising, because the theory of the special functions of mathematical physics can now be based geometrically on the representations of noncompact groups. This is a very beautiful branch of mathematical physics and will soon become part of the general education of theoretical physicists. For these reasons the potential utility of the book goes beyond the particular Coulomb problem.

The last part of the book is devoted to the actual Coulomb levels and to the calculation of transition probabilities and form factors. Since the book was written more progress has been achieved in the relativistic version of the problem, where actually new results have been obtained by group theoretical methods, which at the same time facilitate the rather formidable relativistic calculations in processes such as photoeffects. Perhaps these results will find their way in a future sequel of a book like the one under review.

A. O. BARUT
International Centre
for Theoretical Physics
Trieste, Italy

The Politics of American Science: 1939 to the Present

J. L. Penick, Jr., C. W. Pursell, Jr., M. B. Sherwood, D. C. Swain, eds.
453 pp. The MIT Press, Cambridge, Mass., 1972. \$4.95

The Politics of American Science: 1929 to the Present has now been issued in a revised edition. As a contribution to the history of science in America, it is helpful and useful, for it

illuminates certain aspects of the growth and development of the post-1939 federal scientific establishment, and, as such, carries the story beyond the terminus of historian A. Hunter Dupree's well known *Science in the Federal Government* (1957). Although *The Politics of American Science* is a collection of public documents, not a

formal history like Dupree's book, it can be considered a companion effort. Given the perils of putting the immediate past into proper perspective, perhaps *The Politics of American Science* has more value at this time than would a formal historical narrative and analysis. And, in a field such as the history of science in America in which the number of historical accounts is pitifully small, any contribution that has been reasonably well executed is obviously most welcome.

The editors' emphasis is on the growth of federal scientific agencies and other institutions and groups relevant to their recent history, upon certain patterns of development, change, and decay, which, although they are undoubtedly familiar to the readers of *PHYSICS TODAY* in a general sense, are nonetheless valuable because of the specificity of the attitudes and phenomena contained in the documents themselves. The editors have provided succinct introductions to the documents; the documents themselves are public records. They emphasize what the actors in the drama of the growth of the federal scientific research establishment wanted to insert in the public record. This does not mean that the documents are completely self-serving, or that they are only meaningless rhetoric. There is, for example, much valuable information in many of the documents. And the documents themselves portray the values of two generations of politicians, scientists, and administrators who helped build the federal scientific establishment and articulated its rationale. Now that that establishment has come under serious attack, and now that it is being dismantled, piece by piece, it is essential for both historians and scientists to understand as much as possible about it.

Readers familiar with the original edition will wish to know how the revised edition differs from the first. Onto the older edition, which had sections on preparedness and war, postwar planning for science, the middle years of the 1950's before Sputnik, and the years of response (1957-65), the editors have grafted two new sections. One is a historical overview based on public documents; the other incorporates documents on the questioning of military research and the search for new priorities. Except for minor editorial changes made for the sake of consistency, the sections in the first edition are the same in the revised edition.

The timely publication of the revised edition will hopefully instruct both historians and scientists about the topic of obvious professional relevance and should encourage historians and social scientists, the expert editors included, to pursue further research and inter-

