cause knowledge of classical electromagnetism, basic quantum mechanics, and advanced calculus are sufficient prerequisites. The first five chapters contain a summary of the classical theory of electromagnetism (including such rarely treated topics as nonlinear theories of electromagnetism with their canonical formulation), a discussion of the Green's function description of the scattering process, interaction of classical sources with a quantized electromagnetic field and the Feynman approach to the problem of electrons moving in an external field.

The second part (chapters 6–8) is more difficult, hairy as far a I am concerned. It is intended for graduate students writing dissertations in quantum field theory. I am not qualified to say how effective the authors are in this second part, but judging from the first part it should be excellent.

Its subject matter includes advanced treatment of the theory of interacting electron and photon fields. Starting from the field equations, the authors give a detailed discussion of the S matrix in terms of propagators. The discussion of renormalization is based on a novel method developed by the authors with various applications presented in the last chapter. The nine appendixes are most helpful. I hope that an English translation of this excellent textbook will not be long in coming.

* * *

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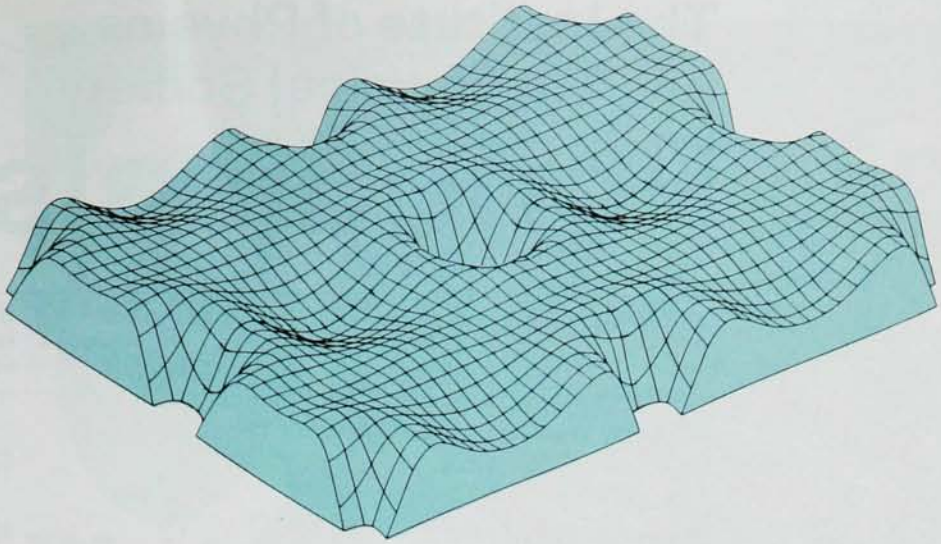

CONDUCTION ELECTRON DENSITY on a 110 plane in aluminum, calculated by the pseudopotential method. This is a sketch of a three-dimensional plot in which electron density is plotted vertically as a function of position in the plane. The calculation is described by Walter A. Harrison in *Pseudopotentials and the Theory of Metals*, W. A. Benjamin, New York, 1966, page 216ff.

A band-wagon map

METHODS IN COMPUTATIONAL PHYSICS, VOL. 8: ENERGY BANDS OF SOLIDS. Berni Alder, Sidney Fernbach, and Manuel Rotenberg, eds. 300 pp. Academic Press, 1968. $16.00

by NEIL ASHCROFT

More than 40 years have elapsed since the first tentative "band structures" of solids were presented to physicists who were then still reacting with caution to the radical changes confronting them both in the "new mechanics" and the "new statistics." The realization that electrons in solids were accommodated not in discrete atomic-like states but in quasi-continuous bands of states goes back first to Arnold Sommerfeld. In his early model of the metallic state, he exposed the curious properties exhibited by a dense uniform collection of electrons.

The crucial observation of William Bragg and his coworkers that the electron distribution was *not* uniform (and in fact followed the crystalline array of ions revealed by x-ray scattering) was incorporated into the theory by Felix Bloch and A. H. Wilson in 1928. They demonstrated that electrons (at least in the one-electron approximation) are arranged not in a single band but in many.

The present volume is devoted to solid-state physicists' great ingenuity and inventiveness in constructing methods for extracting the band structures of solids. The debt to John C. Slater cannot be underestimated; indeed this emerges very clearly in almost every section of the text. He not only provided a sweeping and highly effective approximation for incorporating exchange into the one-electron periodic potential (which nearly all the methods exploit), but he also provided one of the most successful procedures for calculating energy bands ever devised. Slater's method of augmented plane waves, and its refinements between 1937 and the present, is described in the longest of the articles. It is given excellent coverage by L. F. Mattheis, J. H. Wood and A. C. Switendick, who in some detail show how one is led to a secular relation between energy and wave vector. Questions of convergence of the energy eigenvalue with order of the secular equation are, with present techniques, of no great concern.

Perhaps even more rapid convergence is now obtained with a second method, the Korringa-Kohn-Rostoker or Green's-function method. It is described at length by Benjamin Segall and Frank Ham, who are well known in the literature for their accurate applications of the method.

Both methods rely on the nonoverlapping or celebrated muffin-tin approximation to the potential. Both can now be corrected for their inherent deviations from the real situation. The other methods in the book do not make the approximation but do of course make others. Frank Herman and others give a very full description of their thorough and systematic calculation of band structures using the method of orthogonalized plane waves (Conyers Herring, 1940). These are almost entirely first-principle calculations apart from last-minute refinements imposed on the electron–ion potentials by the dictates of experimental fact.

An interesting contrast to the orthogonalized-plane-wave and the other two methods is provided in the re-

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maining chapters. J. C. Phillips and R. Sandrock point out with some force that with reasonable accuracy many of the first-principle calculations can be reproduced by quite small secular determinants that in turn can be derived from a "model Hamiltonian" approximation to the electron-band problem. This idea is vigorously pursued in David Brust's exposition of the pseudopotential method and its application to silicon and germanium. Extension to systems exhibiting hybrid mixtures of free-electron-like states and tighter bound states are provided in the article by Henry Ehrenreich and Laurent Hodges. This method has been contrived to handle metals in the transition groups, and its ability to incorporate relativistic (principally spin-orbit) and ferromagnetic effects augurs well for a useful empirical approach to these physical problems.

With only one omission the book gives, in a series of well-written articles, an excellent summary of the tried and true band-structure techniques. The omission is, of course, the cellular method (also attributed to Slater in its present form). It receives attention although it is not as popular as the others. Graduate students and researchers in solid-state physics will find the text both a useful compendium, and, particularly in Slater's opening account, an interesting verbal map of the route taken by the band wagon over the past few decades.

* * *

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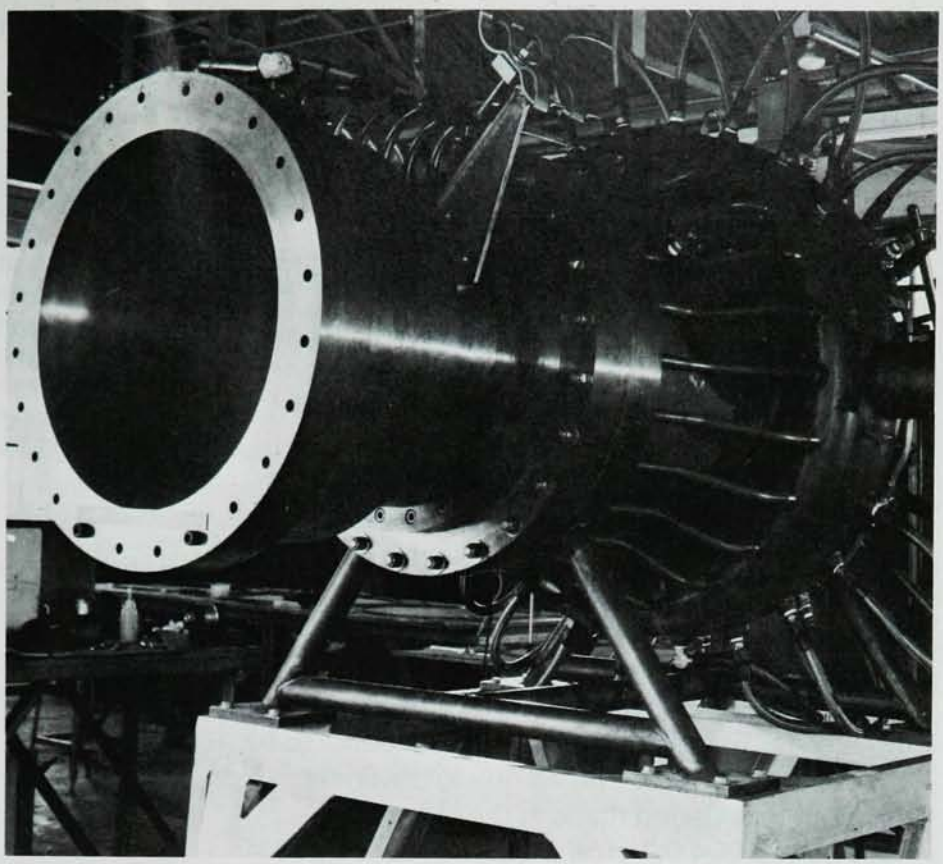

COMBUSTION CHAMBER of the 20-MW MHD generator built by Avco Everett Research Laboratory to power a low-density wind tunnel at the Air Force Arnold Engineering Development Center, Tullahoma, Tennessee.

Introducing MHD

MAGNETOHYDRODYNAMIC ENERGY CONVERSION. By Richard J. Rosa. 234 pp. McGraw-Hill, New York, 1968. $17.50

by JAMES KELLEY

Despite its being at the very frontier of modern methods of energy production, magnetohydrodynamics goes back to Michael Faraday, at least in principle. As Richard J. Rosa (chairman of the MHD Generator Project Board, Avco-Everett Research Laboratory) points out in the introduction to his book, patents for MHD energy conversion had been applied for in the first decade of this century. But really only after World War II could MHD be seriously applied to the energy-conversion process because of the postwar studies in plasma physics, the knowledge gained of the fusion process in nuclear physics and the deeper insights into gas dynamics. Now major producers of electrical power-plant equipment, both fossil and nuclear fueled, are seriously in the MHD energy-conversion business. A number of major electrical utility companies are also involved. So it is safe to say this method is here to stay.

Rosa's book is well designed for an introduction to MHD. A senior student in electrical engineering or a beginning graduate student would find it suitable. From a teaching viewpoint it has some deficiencies; there are no problems of any kind, as illustrations or at the end of chapters. The first three chapters are given over to review. They start with an introduction and general description and go on to ionization and conductivity and then fluid mechanics. These are well done but do presuppose some knowledge of these subjects. Of course ionization is not left there; it is treated throughout and in some detail in the fifth chapter. There is a good discussion (chapter 4) of both the Hall effect and ion slip. Chapters 6 and 7 deal, respectively, with magnet design and a wide variety of essential design parameters.

In some respects the last chapter is the most interesting because the author deals with what will happen to research and development. He deals with the applications. There are, of course, practical engineering problems such as high temperatures (2000–3000K) in a daily operating situation or alternatively high-fired superconductors. In either case the practical engineering problems may be much simpler to discuss than to solve.

There is little doubt, however, that these and other problems will be solved by one means or another.

Rosa discusses costs, which I at least would not care to try to debate. I have gone through that experience comparing fossil-fired and nuclear-fired generating plants and have seen all the calculations end up meaningless and virtually all time schedules turn out wrong. After all that, I am one person who would say, let's try