

part of the reader. This chapter is nonetheless essential, because of special requirements peculiar to Q machines and because the field of plasma diagnostics itself benefited from Q-machine research.

Experiments done on Q machines are divided into four chapters covering instabilities, confinement, waves and complex magnetic geometries, respectively. The major contribution of Q machines to basic plasma physics is probably the identification of resistive drift waves, a variety of "universal" instability driven only by the density gradient. This is a weak instability that can be seen only in a plasma free from all other instabilities. Motley gives a complete account of drift-wave research, including theory, experiment, nonlinear effects, feedback stabilization and effect on confinement. Derivations of equations are only sketched, but a better summary cannot be found elsewhere because contributions from all quarters (not just Princeton!) are here. The subject of drift instabilities is not yet closed, because the threshold magnetic field is 50% higher than theory predicts; this discrepancy is mentioned but perhaps not sufficiently emphasized. The other instability discussed by Motley is the Kelvin-Helmholtz instability in a nonuniform transverse electric field. This is an important but relatively unpublished effect. The treatment by Motley is by far the most exhaustive one on the subject. The parallel Kelvin-Helmholtz instability was, for some reason, left unmentioned.

Plasma losses from Q machines are dominated by effects other than classical collisional diffusion—effects such as endplate recombination, probe losses, transport by oscillations and convection. This complicated picture—even in a uniform magnetic field—is clearly unfolded by Motley; the reader can well imagine what a similarly thorough study of confinement in a torus would involve. The impression one gets from this chapter is the correct one that plasma convection is the primary cross-field loss mechanism in a Q machine, and one would be wise to look for it in other machines.

The chapter on waves emphasizes the ion acoustic wave, which was first seen in a Q machine despite the fact that it is heavily damped when the ion and electron temperatures are nearly equal. This experiment was also the first verification of Landau (collisionless) damping. Motley gives a good account of ion waves; in particular, the statement on collisional damping of ion waves—a more subtle effect than one might expect—is the best there is, despite its brevity. One might have wished for a fuller discussion of pseudowaves and grid-induced effects, on which there is extensive literature. Incidentally, the

useful Sessler-Pearson graph on the ion-wave dispersion relation is reproduced here more clearly than in the original paper.

The use of alkali-metal plasmas in complex magnetic fields has yielded demonstrations of the effectiveness of shear and short connection length in stabilizing drift waves and reducing convection. Motley does not fail also to give an account of the notorious Wendelstein controversy, in which a Q-stellarator group in Garching, Germany, dared to lock horns with the redoubtable C-Stellarator team at Princeton—and got away with it.

Finally, the reader is made privy to the details of constructing a Q machine, in case he is well-funded and so inclined. Here Motley gives the relevant data on ionization potentials, work functions, and so forth. Graphs of tungsten resistivity, emissivity and thermionic emission would have been a welcome addition.

As can be seen from the foregoing, Q-machine research cuts across all of plasma physics. It would have been easy to write a book twice this length. We owe the author a vote of thanks for exercising great restraint and unerring editorial judgment, underplaying results that are uncertain and emphasizing those that are important. Succinctness, however, has its price: The reader would have benefited from more poignant discussions, for instance, of why a radial electric field exists, why contact potentials cause the jump in plasma potential at the limiter, and how a bar of

iron allows upper-hybrid radiation to escape. In discussing collisionless drift waves, no mention was made of the experiment at Fontenay-aux-Roses by Deschamps *et al.* True, this was not done in a Q machine, but it nonetheless has to be mentioned in that context. Otherwise, the book is very complete, particularly in its 341 references. Above all, Motley has given fair treatment to all who have worked in the field. In anything, he is guilty of excessive modesty regarding his own substantial contributions.

It is problematical whether Q machines will continue to be used in the future. They are expensive and difficult to operate. There are now other quiescent plasmas, such as the Double Plasma devices developed at UCLA, which are easier to build and have a higher electron-ion temperature ratio. But the example of meticulous measurement and thorough analysis set by the Q-persons of the 1960's will probably be unequalled in the annals of plasma physics. Motley has captured the spirit of this epoch magnificently in his short monograph. Now if someone would only do the same thing for multipoles...

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The Electromagnetic Field

A. Shadowitz

741 pp. McGraw-Hill, New York, 1975.
\$16.95

The Theory of the Electromagnetic Field

D. M. Cook

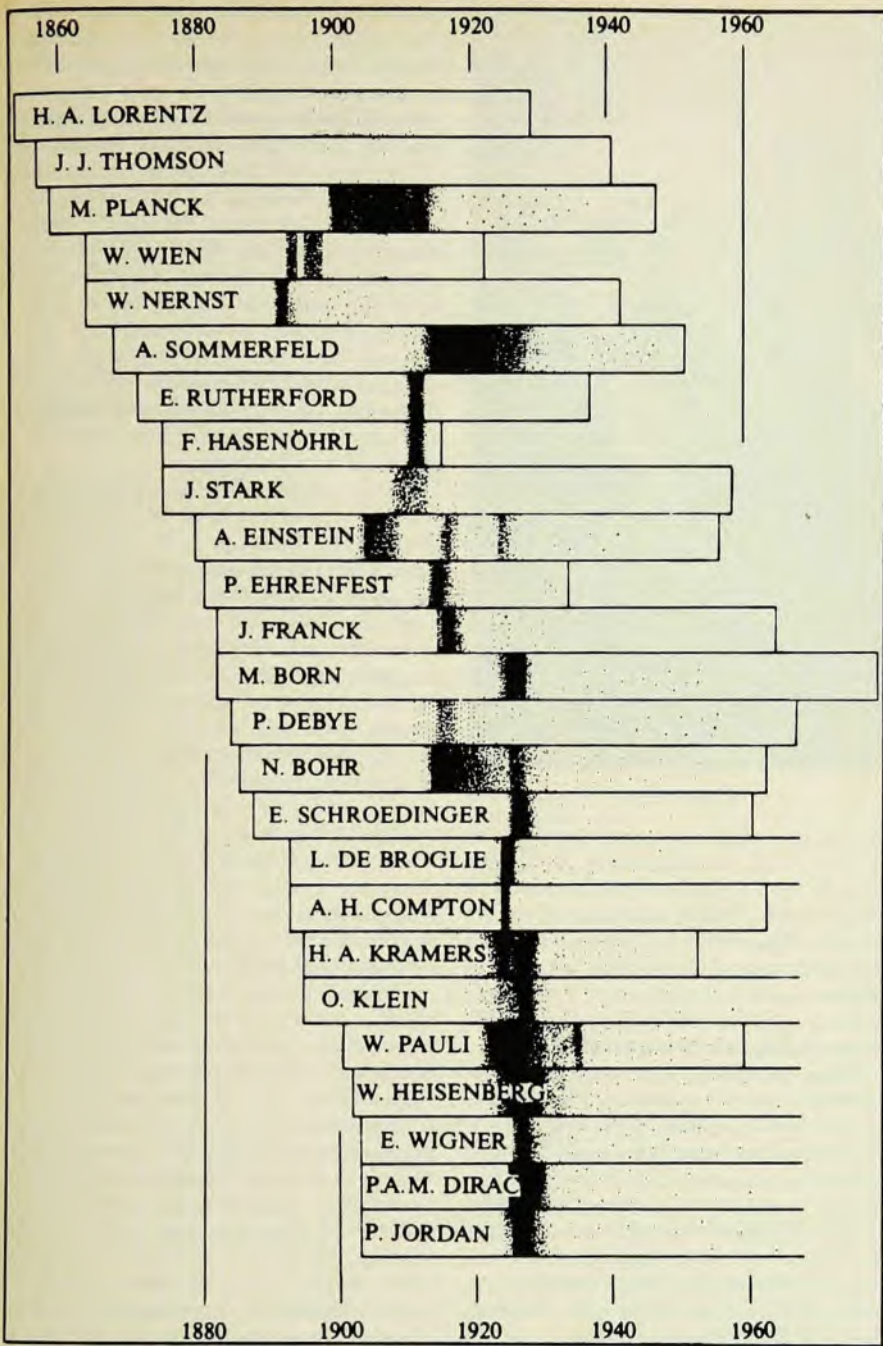
510 pp. Prentice-Hall, Englewood Cliffs, N.J., 1975. \$15.95

Although classical electromagnetic theory is no longer considered a "developing" field, the teaching of this area continuously evolves, as evidenced by new textbooks that treat the material from a variety of viewpoints and that incorporate new methods of instructional presentation. Two such books, David M. Cook's *The Theory of the Electromagnetic Field* and Albert Shadowitz's *The Electromagnetic Field*, both aimed at the intermediate college level (junior-senior), present two different structural approaches to the standard material of electromagnetism.

Cook focusses on the parallel devel-

opment of the phenomenologies of charge and current and introduces the Lorentz force and the **E** and **B** fields simultaneously before moving on to the parallel, but separate, presentation of electrostatics and magnetostatics. He next develops Maxwell's equations and plane electromagnetic waves *in vacuo*, followed by a digression to potential theory. Electromagnetism in the presence of matter is then treated in some depth, and the text is rounded out with radiation theory and the relativistic formulation of Maxwell's equations.

In contrast to Cook's organization, Shadowitz treats electrostatics and magnetostatics in an interwoven fashion through a series of six chapters in which the electric and magnetic aspects are alternated. (By regrouping these chapters electrostatics and magnetostatics can be taught in the traditional parallel sequence). The remainder of the book covers most of the same material as Cook does and contains, in addition, chapters on ferromagnetism, electric circuits and transmission lines. The inclusion of some of these topics reflects Shadowitz's electronic-engineering



The rapid growth of quantum theory during the 1920's is mirrored here by the dark areas showing the active periods of the theory's founders. From *The History of Quantum Theory*.

background and rounds out his attempt to produce a text that is useful to both electrical-engineering and physics students.

Another organizational difference between the two texts is Shadowitz's placement of special relativity soon after Maxwell's equations and the use of relativity in later topics, such as radiation theory. Shadowitz draws heavily on the geometric interpretation of special relativity, though the four-vector formulation is included. Cook, who includes relativity and its relationship to electromagnetic theory at the end of the book, uses a more formalistic analytic approach to the subject.

Both authors supply an abundance of good problems in each chapter, but only Shadowitz includes a large number of worked examples. Cook relegates many of the standard examples to the problems for the sake of compactness, but includes several examples and problems that stimulate the use of a digital computer. Both books are well illustrated, but most of Shadowitz's illustrations are not labeled and so may be used only directly in connection with the text material. Both texts use the rationalized MKSA system of units and both include some discussion of other systems of units as well as unit conversion tables, and both have a preliminary

chapter devoted to mathematical methods.

Though both authors write with clarity and precision, some undergraduate students would respond more favorably to the expanded explanations and numerous worked examples of Shadowitz as contrasted to the compacted style of Cook. Instructors who emphasize applications of electromagnetic theory might prefer Shadowitz to Cook, though Cook's concise treatment might lend itself better to a one-semester course or to courses where theory is emphasized over applications. Either of these books would be suitable as a text for a course in intermediate electromagnetism, but Shadowitz is probably preferable for engineering-oriented courses. Text selection for any course depends to some extent on the style and taste of the instructor and these factors could turn out to be especially important if a choice had to be made between the Cook and Shadowitz books.

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The History of Quantum Theory

F. Hund
260 pp. Barnes & Noble, New York, 1974.
\$20.00

Friedrich Hund was one of the young men growing up in the days when the older Bohr form of the quantum theory was developing into wave mechanics. He wrote this history of the quantum theory from first-hand knowledge. The culmination of the efforts described came in the period a half century ago during 1920-30, and numerous other books dealing with the same period are coming out now. I had hoped that Hund would give personal reminiscences of his relations with the leaders of the field; such interweaving of biography and science can give more life to the narrative. Unfortunately his modesty had led him to make the book entirely impersonal. One would not even learn from it that Hund was a colleague of Peter Debye and Werner Heisenberg in the very active group in Leipzig from 1929 until World War II.

I found particularly useful the full discussion of the early development of the quantum theory, in the period 1900-20; but the attempt to cover in detail those earlier days, as well as the decade 1920-30 has resulted in a great deal of compression. There is mention of many facts, with many equations, that are not discussed in enough detail to be very comprehensible to an elementary reader.

Hund hoped that the book would ap-