BOOK REVIEWS

Plasma Initiation

Plasma Physics. An Introduction to the Theory of Astrophysical, Geophysical, and Laboratory Plasmas. PETER A. STURROCK. Cambridge University Press, New York, 1994. xii, 335 pp., illus. $64.95 or £45; paper, $24.95 or £17.95.

Introduction to Plasma Physics. ROBERT J. GOLDSTON and PAUL H. RUTHERFORD. Institute of Physics, Philadelphia, 1995. xviii, 491 pp., illus., + diskettes. $196 or £98; paper, $59 or £29.50.

Plasma Physics. An Introductory Course. RICHARD DENDY, Ed. Cambridge University Press, New York, 1995. xx, 513 pp., illus. Paper, $39.95 or £24.95.

In teaching an introductory course in plasma physics, the urge is always to present topics that are correct, defensible, and encouraging. The result tends to be that the emphasis falls on free-standing, elegant pieces of theory that are brief and seem self-evident: linear waves in a cold plasma, adiabatic particle drifts, ideal magnetohydrodynamic equilibria, Debye screening of colliding charged particles, Landau damping as an initial value problem. What tends to get short shrift is just how messy and *sui generis* plasma experiments are likely to be, how labored and uncomfortable are the present fits of textbook theory to most observations, how much of a sense of humor is sometimes required to go on. Students can emerge misunderstanding the situation.

The three books under review are all conscientious attempts to start plasma students off in intellectually coherent directions. Sturrock's book originates in over 30 years of teaching the introductory plasma course at Stanford. The one by Goldston and Rutherford follows their course for "advanced undergraduates" at Princeton. The Dendy volume is a collective one, with diverse self-contained contributions from 20 British authors; pitched at a higher level, it is aimed more at advanced graduate students or recent Ph.D.s and amounts to the contents of a strenuous summer school. All three volumes are carefully written, artfully edited, earnest, and "mainstream."

Sturrock's text is the cleanest, the clearest, the most accessible, and perhaps the most oversimplified. It has numbered exercises and shows the hand of an experienced pedagogue. Of the three, it is the least influenced by fusion research or other applications. Experimental results are few and qualitative, but pertinent.

Goldston and Rutherford cover much of the same material as Sturrock but with more of a fusion-research emphasis, as might be expected: cylindrical and toroidal geometry appears early and often, and there are more equilibria and "instabilities." Goldston and Rutherford, too, have numbered exercises that are thought-provoking and support the textual material.

The Dendy volume gains in topical interest what it loses in coherence from being a cafeteria of offerings by different authors. The titles of the individual chapters range from "Industrial plasmas" (P. C. Johnson) through "Gravitational plasmas" (J. J. Binney) to "How to build a tokamak" (T. N. Todd). The chapters aim at sampling very recent thinking on a wide variety of current topics, are not always pedagogic in tone, and are sometimes unabashedly speculative.

All three books are to be recommended for their smooth presentations, their literacy, and their occasional virtuosity. Their main lack, as far as this reviewer is concerned, is that there is seldom any statement of how fragile plasma physics still is, how far removed in style and substance from the more mature branches of physics. Particularly to one who spends part of his time in fluid mechanics, the style of much of plasma physics can sometimes seem reckless, uninformed, and suavely shallow. Why should ideal steady states be taken seriously as models of reality when they have been known for almost a century not accurately to represent hydrodynamic shear flows? If anyone knows, he or she should say. What should we make of a magnetofluid description whose viscous stress tensor is uncertain by orders of magnitude? Who can say that the Vlasov equation and the Vlasov equation with a collisional correction lead to "essentially" the same results, even over "short time scales"?

Electricity and magnetism have been an active research area for over two centuries, classical mechanics for over three. Their development and practical applications are not finished yet. Plasma physics, very much younger, spans the product space of the two, and also needs a great deal of support from statistical mechanics, kinetic theory, hydrodynamics, and atomic physics. Compared to what likely could be known about plasmas, very little is. Textbooks and monographs ought to reflect the true state of development of the field they address. If modesty and uncertainty are in order, that should be their tone. These books are intelligent ones, but they are not always modest enough.

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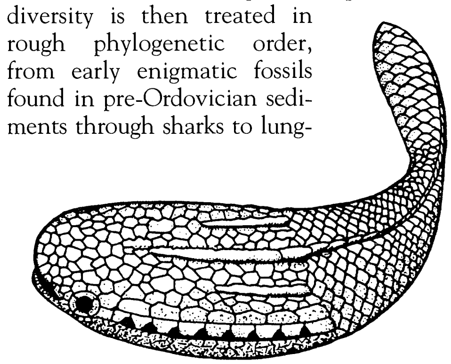
Other Books of Interest

The Rise of Fishes. 500 Million Years of Evolution. JOHN A. LONG. Johns Hopkins University Press, Baltimore, MD, 1995. 223 pp., illus. $49.95.

The group of organisms loosely called "fishes" contains over half of all vertebrates (about 25,000 extant species). Not only do these species exhibit astonishing diversity in structure, behavior, and physiology but clades within the "fishes" gave rise to terrestrial vertebrates and hence to modern amphibians, reptiles, birds, and mammals. Some clades of fishes are more closely related to tetrapods than they are to other aquatic fishlike taxa. Deciphering the pattern of fish evolution thus makes a major contribution to our understanding of vertebrate diversity as well as provides insight into the origin of terrestrial life.

This book is a colorfully and copiously illustrated semi-popular description of fish evolution that focuses on the fossil record of fishes. A brief introductory section explains the process of fossilization, continental drift, principles of phylogenetic analysis, and basic features of vertebrate anatomy relevant to understanding the descriptions of fossil taxa in subsequent chapters. Fish diversity is then treated in rough phylogenetic order, from early enigmatic fossils found in pre-Ordovician sediments through sharks to lung-



"*Astrapsis* is one of the oldest vertebrates known from North America, and was initially described from fragmentary plates of bone from the Late Ordovician Harding Sandstone of Colorado by Charles Doolittle Walcott. In recent years more complete material has been found enabling this new reconstruction of the fish." [From *The Rise of Fishes*; after the work of David Elliott]