

the global atmospheric electrical circuit, ionospheric and magnetospheric electric fields and currents, upper atmospheric plasma dynamics, and naturally generated electromagnetic waves. This monograph is the first one of which I am aware to bring all of these topics together. Until recently the sciences of electrodynamics in the lower atmosphere and in the upper atmosphere have tended to evolve as separate disciplines, diverging from their common origins in the 18th century, when scientists like Benjamin Franklin viewed lightning and the polar lights as related electrical phenomena. In the past few years, however, there has been a renewed awareness of the electrodynamical coupling among atmospheric regions. This book is therefore a timely contribution to the field.

Many of the current scientific questions concerning atmospheric electrodynamics are of a fundamental nature. How do atmospheric aerosols and cloud particles interact with each other and with atmospheric ions to bring about the separation of electrical charges? Although many mechanisms have been proposed, the detailed microphysics of each and their relative importance in phenomena like thundercloud electrification are poorly understood. What factors determine the dynamical behavior of lightning strokes? The very nature of lightning makes it difficult to study comprehensively, yet an understanding of lightning has considerable practical value. What phenomena are involved in maintaining the positive charge of the ionosphere with respect to the earth? Thunderstorms are believed to be the primary charging mechanism, but much of the theory behind the global electrical circuit remains to be tested. How do ionospheric electric fields and currents interact with upper atmospheric winds and with the magnetosphere? How does the solar wind interact with the magnetosphere to energize the magnetospheric plasma? In the ionosphere and the magnetosphere, electrical phenomena become pervasive and play a major role in the structure and dynamics of the entire region. What electrodynamical processes determine the spectrum of electromagnetic waves generated in thunderclouds and in the magnetosphere? These waves can provide powerful diagnostic tools for studying the electrodynamical processes.

In this book Volland gives a brief overview of different aspects of atmospheric electrodynamics and then goes on to address the questions listed above, developing mathematical models intended to simulate certain features of select-

ed phenomena. Although the mathematics are not always simple, the development of each model usually results in enough simplifications to permit an analytical solution. There are frequent analogies with equivalent electric circuits composed of wires, resistors, capacitors, inductors, and generators. Because many of the phenomena that are modeled are understood only poorly, the models that are presented must be considered more illustrative than definitive. Unfortunately, in many cases the parameters that are used in the models tend to conceal or distort some of the key physical processes that occur, a high price to pay for simplified analytical solutions. For example, the solar wind and magnetospheric plasmas are occasionally represented as ohmic media, in which current and electric field are linearly related by a conductivity parameter, even though collisionless plasmas come nowhere near to satisfying Ohm's law. The reader should therefore be cautious about trying to extend the predictions of these models beyond the results presented by Volland.

The book will be of interest to researchers with a background in electromagnetic theory who wish to learn more about applications of the theory to a wide range of problems in atmospheric physics. Because the book is selective rather than comprehensive, it will have only limited use as a reference work. Its greatest value may be in helping to stimulate a broader perspective among researchers in the field of atmospheric electrodynamics.

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Planetary Systems

Planetary Rings. RICHARD GREENBERG and ANDRÉ BRAHIC, Eds. University of Arizona Press, Tucson, 1984. xii, 784 pp., illus. \$35. Space Science Series. Based on a conference, Toulouse, France, Sept. 1982.

The importance and timeliness of this compendium of review papers are highlighted by the range of the unsolved problems that are discussed in it. The first issue (which is not raised in a paper "Unsolved problems in planetary ring dynamics" by Borderies, Goldreich, and Tremaine) concerns the state of internal relaxation of the structure of the ϵ ring of Uranus. We do not know whether the shape of the radial profile of the ring is

conserved even through periapsis (Elliot and Nicholson, "The rings of Uranus," figs. 8a and 8b). We may expect to learn whether it is from the observation from Space Telescope of a suitable stellar occultation by the ring (Smith, "Future observations of planetary rings from groundbased observatories and earth-orbiting satellites").

A second, more general issue concerns the observation of unexplained circular or nearly circular sharp edges (elliptical ones or those exhibiting wave structure seem either to be explained or to be well on the way to being explained; see "Waves in planetary rings," by Shu, "Dynamics of narrow rings" by Dermott, and the paper by Borderies *et al.*). The sharp edges show themselves mainly within the rings of Saturn and appear most impressively within the D ring, but they also appear within Cassini's division and at a few places within the C ring. (The absence of an adequate description of the D ring, which might have appeared in any of three papers, is the principal shortcoming of the book.) This concentration toward the inner portion of Saturn's rings suggests that perturbations by unseen satellites may not be the only mechanism for production of these sharp edges.

A third issue is that it remains to be seen whether spokes impinge in any way on the dynamics of the observed radial structures within Saturn's B ring. The need for at least one observing campaign from Space Telescope is expounded in the paper by Smith. Such a campaign combined with observations of many stellar occultations by the B ring from the same telescope should put our entire view of this ring on a new footing.

A welcome departure from a strict adherence to Occam's razor is provided by Weidenschilling, Chapman, Davis, and Greenberg in their paper, "Ring particles: collisional interactions and physical nature." Their principal suggestion is that particles accrete upon one another to grow to a maximum size ("dynamical ephemeral body") only to be disrupted. It will be some time before dynamical models can accommodate this proposed complication. A step on the way may be seen in the discussion of the behavior of a bimodal particle size distribution near the end of the review "Collision-induced transport processes in planetary rings" by Stewart, Lin, and Bodenheimer. In this context the issue of a diffusive separation of the two sizes has yet to be addressed. Such a process may help in the production of sharp circular edges.

Borderies *et al.* close their discussion

by raising the chief problem of the outer planetary systems as they appear to us: the repeated appearance of short dynamical time scales. Their context is that of the reaction of dissipation of perturbations by satellites back on the satellites themselves. It may be that several satisfactory resolutions of this problem will appear and that we need not be diverted into generation of scenarios for holocausts à la Nemesis.

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Adaptation in Sticklebacks

A Functional Biology of Sticklebacks. R. J. WOOTTON. University of California Press, Berkeley, 1985. xiv, 265 pp., illus. \$29.75. Functional Biology Series.

This is the second volume of a series intended to explain how organisms "make a living." The stickleback fishes, especially the three-spined stickleback (*Gasterosteus aculeatus*), are particularly appropriate for this purpose because their biology has been studied thoroughly from diverse perspectives. In chapter 1 Wootton argues that theory can illuminate one's understanding of an animal's daily activity and that important theoretical insights can be gained by focusing on a single, well-studied species. Aspects of genetics, morphology, behavior, and physiology and their influences on growth, reproduction, distribution, and mortality are taken up in the next nine chapters. The final chapter attempts to relate some of this information to life history theory. This book is greatly updated compared to Wootton's previous encyclopedic work, *The Biology of the Sticklebacks*, but has a narrow focus on information needed to use sticklebacks in addressing theoretical problems of ecology and evolution.

This book nicely summarizes a vast and diverse literature on the ecology, evolution, and organismal biology of sticklebacks and identifies numerous areas in which research would be particularly rewarding. Although this synthesis is generally successful, Wootton occasionally has neglected some very important studies. Most of the chapters open with brief conceptual introductions. Theoretical issues and similar critical or well-studied cases in other animals are treated at appropriate points, but this development is uneven. Sections on growth and reproductive effort, topics in

which Wootton has made original contributions, appear to be well developed; but the treatment of some other areas, systematics, morphology, and ecological genetics for example, is weaker. Some information is not traceable by citation to the original papers, and Wootton sometimes cites his earlier book rather than the primary literature. The closing chapter on theory of life history evolution is disappointing. Although the theory is suited to account for interpopulation differences, Wootton focuses on species-specific properties. Thus, no critical insights emerge. In addition, other theoretical issues concerning which stickleback biology could make fundamental contributions are neglected. The theory of clines, the maintenance of genetic diversity, speciation, the evolution of behavior (treated only in the context of parental investment), rates of evolution, and the adaptationist program beg for development.

Despite these criticisms, which admittedly reflect my own interests, this is a very readable book and an exceedingly useful and compact source of information on the ecology and evolution of a group that has the potential to provide major theoretical insights.

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Reprints of Books

Previously Reviewed

Phylogenetic Patterns and the Evolutionary Process. Method and Theory in Comparative Biology. Niles Eldredge and Joel Cracraft. Columbia University Press, New York, 1984. Paper, \$15. Reviewed 210, 1239 (1980).

A Slot Machine, a Broken Test Tube. An Autobiography. S. E. Luria. Harper and Row, New York, 1985. Harper Colophon Books. Reviewed 225, 46 (1984).

Books Received

The Control of Fish Migration. R. J. F. Smith. Springer-Verlag, New York, 1985. xvi, 243 pp., illus. \$49.50. Zoophysiology, vol. 17.

Craniofacial Mesenchyme in Morphogenesis and Malformation. Kenneth S. Brown *et al.*, Eds. Liss, New York, 1984. xviii, 146 pp., illus. \$44. Birth Defects: Original Article Series, vol. 20, No. 3. From a symposium, Seattle, June 1983.

Culture, Feeding and Diseases of Commercial Flatfish Species. E. W. Liewes. Balkema, Rotterdam, 1984. viii, 104 pp., illus. \$18.50.

DNA Repair. Errol C. Friedberg. Freeman, New York, 1984. x, 614 pp., illus. \$39.95.

Ecology. The Experimental Analysis of Distribution and Abundance. Charles J. Krebs. 3rd ed. Harper and Row, New York, 1984. xvi, 793 pp., illus. \$33.50.

Herbivore Nutrition in the Subtropics and Tropics. F. M. C. Gilchrist and R. I. Mackie, Eds. Science Press (Donker), Houghton, South Africa, 1984. 779 pp., illus. \$95. From a symposium, Pretoria, South Africa, April 1983.

Illustrated Encyclopedia of Human Histology. R. V. Krstić. Springer-Verlag, New York, 1984. x, 450 pp. \$38.50.

Microcomputers in Education Conference. Literacy Plus+. (Tempe, Ariz., March 1984.) Ruth A. Camuse, Ed. Computer Science Press, Rockville, Md., 1984. xii, 465 pp. \$35.

Models and Parameters for Environmental Radiological Assessments. Charles W. Miller, Ed. Technical Information Center, U.S. Department of Energy, Oak Ridge, Tenn., 1984 (available as DE81027154 from National Technical Information Service, Springfield, Va.). vi, 150 pp. Paper, \$12. DOE/TIC-11468.

Models in Dermatology. H. I. Maibach and N. J. Lowe, Eds. Karger, Basel, 1985. Two volumes. Vol. 1, Dermatology. x, 374 pp., illus. \$149.75. Vol. 2, Dermatopharmacology and Toxicology. x, 370 pp., illus. \$149.75.

Molecular Biology of Development. Eric H. Davidson and Richard A. Firtel, Eds. Liss, New York, 1984. xxvi, 685 pp., illus. \$96. UCLA Symposia on Molecular and Cellular Biology, New Series, vol. 19. From a symposium, Steamboat Springs, Colo., April 1984.

Monoclonal and Anti-Idiotypic Antibodies. Probes for Receptor Structure and Function. J. Craig Ventre, Claire M. Fraser, and Jon Lindstrom, Eds. Liss, New York, 1984. xii, 194 pp., illus. \$46. Receptor Biochemistry and Methodology, vol. 4.

Morphogenesis of the Brain in Staged Rhesus Monkey Embryos. Agnes A. M. Gribnau and Leonardus G. M. Geijsberts. Springer-Verlag, New York, 1985. viii, 69 pp., illus. Paper, \$19.50. Advances in Anatomy, Embryology and Cell Biology, 91.

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National Parks, Conservation, and Development. The Role of Protected Areas in Sustaining Society. Jeffrey A. McNeely and Kenton R. Miller, Eds. Smithsonian Institution Press, Washington, D.C., 1984. xiv, 825 pp., illus. Paper, \$25. From a congress, Bali, Indonesia, Oct. 1982.

1985 Yearbook of Astronomy. Patrick Moore, Ed. Norton, New York, 1985. 208 pp., illus. Paper, \$9.95.

Nonverbal Sex Differences. Communication Accuracy and Expressive Style. Judith A. Hall. Johns Hopkins University Press, Baltimore, 1985. xiv, 207 pp. \$24.

The North American Grasshoppers. Vol. 2, Acrididae: Oedipodinae. Daniel Otte. Harvard University Press, Cambridge, Mass., 1984. x, 366 pp., illus., + plates. \$60.

On the Centre of Gravity of the Human Body, as Related to the Equipment of the German Infantry Soldier. W. Braune and O. Fischer. Springer-Verlag, New York, 1984. viii, 96 pp., illus. \$29. Translated from the German edition (1889) by P. G. J. Maquet and R. Furlong.

Optical Radiation Detectors. Eustace L. Dereniak and Devon G. Crowe. Wiley, New York, 1984. xiv, 300 pp., illus. \$42.50.

Perceiving Ordinary Magic. Science and Intuitive Wisdom. Jeremy W. Hayward. New Science Library (Shambhala), Boulder, Colo., 1984 (distributor, Ramdom, New York). xii, 324 pp. Paper, \$9.95.

Perspectives in Theoretical Stereochemistry. I. Ugi *et al.* Springer-Verlag, New York, 1984. xviii, 247 pp., illus. Paper, \$19.30.

Pesticides and Human Health. William H. Hallenbeck and Kathleen M. Cunningham-Burns. Springer-Verlag, New York, 1985. xii, 166 pp. \$24.80.

Petunia. Kenneth C. Sink, Ed. Springer-Verlag, New York, 1984. xiv, 256 pp., illus. \$39. Monographs on Theoretical and Applied Genetics, 9.

Sustained Attention in Human Performance. Joel S. Warm, Ed. Wiley, New York, 1984. xvi, 352 pp., illus. \$44.95.

Thermal Power Plants and Environmental Control. L. A. Richter, E. P. Volkov, and V. N. Pokrovsky. P. S. Neporozhny, Ed. Mir, Moscow, 1984. 312 pp., illus. \$7.95. Translated from the Russian edition (Moscow, 1981) by V. Afanasyev.

Thermodynamics of Silicates. V. I. Babushkin, G. M. Matveyev, and O. P. Mchedlov-Petrosyan. Springer-Verlag, New York, 1985. xvi, 459 pp., illus. \$98. Translated from the 4th Russian edition (Moscow) by B. N. Frenkel and V. A. Terentyev.

Time-Related Single Photon Counting. Desmond V. O'Connor and David Phillips. Academic Press, Orlando, Fla., 1984. x, 288 pp., illus. \$45.

Time's Arrows. Scientific Attitudes toward Time. Richard Morris. Simon and Schuster, New York, 1985. 240 pp. \$17.95.

Two-Dimensional Gel Electrophoresis of Proteins. Methods and Applications. Julio E. Celis and Rodrigo Bravo, Eds. Academic Press, Orlando, Fla., 1984. xvi, 487 pp., illus., plates. \$69.50.

Universe. William J. Kaufmann, III. Freeman, New York, 1984. xvi, 594 pp., illus. \$32.95.