

rather similar in behavior to the sun, others quite different. And recently attention has turned to the possibility that whole galaxies are maintaining their magnetic fields through dynamo action.

These volumes record, respectively, the 11 invited lectures and 46 contributed papers presented at a NATO Advanced Study Institute on the dynamo problem. Though the full range of objects in the universe with magnetic fields is mentioned, the institute understandably focused primarily on the solar and planetary cases, about which we know so much more. Extended workshops and institutes on the dynamo problem that draw together astrophysicists and geophysicists as well as applied mathematicians really do work, because there is so much physics in common in the different dynamos. For example, rotation is a crucial component, which increases the complexity of fluid motions in ways that enhance dynamo action. It is no coincidence that the sun, the Earth, Jupiter, and Saturn, all of which have pronounced rotation, have relatively strong magnetic fields. In particular, rotation tends to generate helical motion and differential rotation, the combination of which is particularly conducive to dynamo action, including the production of dynamo "waves" and magnetic field reversals. Thus particular attention must be given to the hydrodynamics of rotating fluids in the interactions with magnetic fields, which these books do.

One of the fascinations and frustrations of dynamos is that they must be studied either in nature or on the computer. Laboratory models of simply connected fluid dynamos are extremely difficult to produce, because spatial scales are too small to avoid very fast dissipation of the currents. But the dynamo problem is a "laboratory" for chaos theory. The nonlinear dynamics of dynamos includes bifurcations, limit cycles, and strange attractors in abundance. Magnetohydrodynamic turbulence is a prime component of the theory as well. Because of the richness of its physics and mathematics, the dynamo problem tends to hold the interest of applied mathematicians for long periods. For example, Paul Roberts, whose lectures provide an overall introduction to these volumes, has productively devoted decades of his career to it. In the 1950s, when dynamo theory as a mathematical construct was first developing, the subject was regarded as somewhat treacherous because promising series-expansion solutions often diverged when more terms were added. Now, highly truncated systems (well represented in these volumes) are studied with abandon. The problem was that the motion fields considered in the early days did not have enough of the relevant physics, such as rotation, in their structure to produce rap-

idly converging solutions.

Much progress in basic understanding of dynamo processes is represented in these volumes. The interactions among rotation, magnetic fields, and thermally driven motions such as convection are subtle and complex and require particularly careful analysis. These topics are well represented. But it cannot be said yet that there exists anything like a true predictive theory for either solar or planetary magnetism. Some solar dynamo theorists thought they had found one in the 1970s, but that was before the reality check of full hydromagnetic dynamo calculations, as well as inferences of the interior rotation of the sun from the new techniques of helioseismology. Roberts correctly warns that kinematic dynamo theory, in which the motions are assumed rather than predicted from physical principles, can go very wrong if the guess of the motion fields is poor. Now the solar theorists have gone "back to basics," but with a new emphasis on the boundary between the solar convection zone (the outer 30 percent of the sun) and the radiative interior. And no one has yet devised a quantitative theory to explain the sporadic reversals of the Earth's field, reversals that have probably had significant influence on the evolution of life because of the likely massive increases in solar particle fluxes reaching the lower atmosphere and surface during the reversal phase.

So the applied mathematicians and fluid dynamicists still have plenty to work on. I have myself recently returned to research on the solar dynamo and related problems following more than eight years as a full-time administrator. The "pull" of this problem, like the pull of opposite magnetic polarities to each other, was just too great to resist, especially given the development of new observations of the solar interior. These volumes are providing me with a valuable reference on the overall state of the subject, as well as on current concerns and who is actively contributing. The lectures are particularly comprehensive and should provide useful tutorials for newcomers to the area. Most also contain extensive historical references.

I see the future of this subject lying heavily in the area of theories of transition regions, whether between the convection zone and interior of the sun or between the core and the mantle of the Earth. The details of these regions are probably crucial to understanding the dynamics that drives the respective dynamos. I would thus expect to see increased emphasis on boundary layer dynamics, mixing, and local and global waves, as well as effects of topographic features in the case of the Earth, with perhaps some de-emphasis on dynamos driven by convection in the bulk of stars and plane-

tary interiors. It will be interesting to see whether another workshop on dynamos held in, say, 2002, will verify this shift.

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Cell Death and Immunity

Apoptosis and the Immune Response.
CHRISTOPHER D. GREGORY, Ed. Wiley-Liss,
New York, 1995. x, 416 pp., illus. \$89.95 or £69.

Conceptual theories only rarely have a strong impact on experimental fields. One case occurred in 1959, when the concept of natural selection was applied at the cellular level to the development of immune responses, and modern immunology emerged as a consequence. F. Macfarlane Burnet, who is largely responsible for this clonal selection theory, proposed it in part to account for the phenomenon of self-tolerance, the tendency of the immune system not to react with the body's own molecules. To explain self-tolerance, Burnet proposed that antigen-specific cells with potential self-reactivity are "readily disposed of by assuming that—at this particular stage of embryonic life—contact with the corresponding antigen pattern results in the death of the cell" (*The Clonal Selection Theory of Acquired Immunity* [Vanderbilt Univ. Press, 1959], p. 58). The importance of cell death in other developmental systems had been recognized a few years earlier (A. Glucksmann, *Biol. Rev.* 26, 59 [1951]), and active cell death formally became "apoptosis" in 1972 (J. F. R. Kerr *et al.*, *Br. J. Cancer* 26, 239). Arguably, though, it was when Burnet's clonal deletion (now called "negative selection") became a focus of study 30 years after the formulation of his original theory that interest in apoptosis in the immune system revived. Since the late 1980s interest in apoptosis has had an explosive growth, mostly because its molecular regulation appears to be accessible to our probing.

Now a collection of reviews discussing apoptosis in the immune system has been compiled by C. D. Gregory. All but two of the papers focus on apoptosis in T and B lymphocytes, and only one (an excellent review of apoptosis in hematopoiesis) considers cell death in any other cell type. Topics covered include apoptosis in immature and mature T cells, in normal B cells, in B lymphomas, and in CD5⁺ B cells and apoptosis in HIV infection. There are two reviews on the Fas/CD95 molecule and a welcome review on the recognition and phagocytosis

of apoptotic cells. In general, the reviews are erudite and complete (up to about mid 1994). Overall they cover the majority of what we know regarding the phenomenon of apoptosis in lymphocytes.

Apoptosis is "hot." Immunology has always been either hot or frustratingly abstruse, depending on one's perspective. *Apoptosis and the Immune Response* should be sizzling (in an abstruse way). It isn't. Though it is by no means "death by review," neither is it a scientific page-turner. The reviews do what they can to discuss where apoptosis occurs, what triggers (or prevents) it, and even what function it may have in a larger context. We get a good idea of the prevalence and importance of apoptosis in the immune system and even gain some insights, but something critical is, probably inevitably, missing.

So be warned: We do not know how apoptosis actually occurs. We knew even less at the time these reviews were written. Most of them go over the same ground in describing the molecular basis for active cell death and its regulation, and of course there is no consensus on (or really even a proposal regarding) the mechanism. Meanwhile, the fundamental machinery of apoptosis is being examined in a variety of systems (many not described here) and we do not yet know how this growing understanding will affect fields such as immunology. When we do, maybe that will be sizzling.

Each chapter attempts, with more or less success, to review the immunology so that the apoptosis being considered has a context. Unfortunately, I doubt that this will (except perhaps in the case of the chapters on hematopoiesis and phagocytosis) bring the immunology within the grasp of readers who have previously avoided the field. The book thus is probably most suited to individuals with a passion for understanding apoptosis as it specifically applies to lymphocytes and with some acquaintance with the ins and outs of modern immunology. For these people, there is a lot of useful information here.

While the clonal selection theory changed the course of modern immunology, the application of apoptosis research to the immune system has only begun to create ripples (though some of the ripples are interesting). Trevor Howard advised Joseph Cotten to "leave death to the professionals" in Graham Greene's script for *The Third Man*, although he naturally meant another sort of professional (despite the noir pharmaceutical subplot of the story). He also warned that "death's at the bottom of everything." We'll see.

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Books Received

Akathisia and Restless Legs. Perminder Sachdev. Cambridge University Press, New York, 1995. xiv, 425 pp. \$69.95.

The Antisocial Personalities. David T. Lykken. Erlbaum, Hillsdale, NJ, 1995. x, 259 pp., illus. \$49.95; paper, \$24.50.

Applied Analysis of the Navier-Stokes Equations. Charles R. Doering and J. D. Gibbon. Cambridge University Press, New York, 1995. xiv, 217 pp. \$59.95; or \$24.95. Cambridge Texts in Applied Mathematics.

Archaea: A Laboratory Manual. Book 1, Halophiles. S. DasSarma and E. M. Fleischmann, Eds. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY, 1995. xvi, 280 pp., illus. Spiralbound, \$65.

Are We Alone? Philosophical Implications of the Discovery of Extraterrestrial Life. Paul Davies. Basic-Books, New York, 1995. xvi, 160 pp., illus. \$20.

Biogeochemistry of a Forested Ecosystem. Gene E. Likens and F. Herbert Bormann. 2nd ed. Springer-Verlag, New York, 1995. xii, 159 pp., illus. Paper, \$29.95.

Biological Control of Social Forest and Plantation Crops Insects. T. N. Ananthakrishnan, Ed. Science Publishers, Lebanon, NH, 1995. xii, 227 pp., illus. \$72.

Cell Adhesion and Cancer. I. Hart and N. Hogg, Eds. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY, 1995. vi, 165 pp., illus. \$75. Cancer Surveys, vol. 24.

Chironomidae [Diptera] of Japan. Manabu Sasa and Mihoko Kikuchi. University of Tokyo Press, Tokyo, 1995. vi, 333 pp., illus. \$105.

Chronicles of the Frigate Macedonian, 1809-1922. James Tertius de Kay. Norton, New York, 1995. 336 pp. \$25.

Chrysophyte Algae. Ecology, Phylogeny and Development. Craig D. Sandgren, John P. Smol, and Jørgen Kristiansen, Eds. Cambridge University Press, New York, 1995. xiv, 399 pp., illus. \$79.95. From a symposium, Kingston, Ontario, Canada, Aug. 1991.

City of Bits. Space, Place, and the Infobahn. William J. Mitchell. MIT Press, Cambridge, MA, 1995. vi, 225 pp., illus. \$20.

Civil Space in the Clinton Era. Partners in Space . . . 2001. Donald R. McConathy and Paula Korn, Eds. American Astronautical Society, San Diego, CA, 1995 (distributor, Univelt, San Diego, CA). xiv, 278 pp., illus. \$70; paper, \$50. Science and Technology Series, vol. 85. From a meetings, Crystal City, VA, March and Nov. 1994.

Dinosaur Tracks and Other Fossil Footprints of the Western United States. Martin Lockley and Adrian P. Hunt. Columbia University Press, New York, 1995. xxii, 338 pp., illus. \$29.95.

Directory of Electronic Journals, Newsletter and Academic Discussion Lists. Ann Okerson, Ed. 5th ed. Association of Research Libraries, Washington, DC, 1995. iv, 760 pp. Paper, \$62; to ARL member libraries, \$41.

Disinfectants. Actions and Applications. H. A. McDaniel, Ed. Office International des Epizooties, Paris, 1995. Part 1, 248 pp. Paper, \$50 or FrF265. Part 2, 248 pp., Paper, \$50 or FrF265. Scientific and Technical Review, vol. 14, nos. 1-2 (1995).

The Dynamic Nature of Ecosystems. Chaos and Order Entwined. Claudia Pahl-Wostl. Wiley, New York, 1995. xiv, 267 pp., illus. \$79.95.

Early Transition Metal Clusters with π -Donor Ligands. Malcolm H. Chisholm, Ed. VCH, New York, 1995. xii, 289 pp., illus. \$115. Chemistry of Metal Clusters.

Electroporation Protocols for Microorganisms. Jac A. Nickoloff, Ed. Humana, Totowa, NJ, 1995. xx, 372 pp., illus. Spiralbound, \$69.50. Methods in Molecular Biology, 47.

Encyclopedia of Environmental Biology. William A. Nierenberg, Ed. Academic Press, San Diego, CA, 1995. Vol. 1, A-E. xvi, 767 pp., illus. Vol. 2, F-N. xiv, 654 pp., illus. Vol. 3, O-Z, Index. xiv, 693 pp., illus. The set, \$475 (until 30 Sept., \$395).

Epidemiology and the Delivery of Health Care Services. Denise M. Oleske, Ed. Plenum, New York, 1995. xvi, 235 pp., illus. \$45.

The Good Ship. Ships, Shipbuilding and Technolo-

gy in England 1200-1520. Ian Friel. Johns Hopkins University Press, Baltimore, MD, 1995. 208 pp., illus. \$35.95.

Handbook of Culture and Mental Illness. An International Perspective. Ihsan Al-Issa, Ed. International Universities Press, Madison, CT, 1995. xiv, 391 pp. \$52.

Introduction to Clinical Psychology. Lynda A. Heiden and Michel Hersen, Eds. Plenum, New York, 1995. xviii, 409 pp., illus. \$39.50.

Introduction to Geochemical Modeling. Francis Albarède. Cambridge University Press, New York, 1995. xx, 543 pp., illus. \$89.95.

Introduction to Space Physics. Margaret G. Kivelson and Christopher T. Russell, Eds. Cambridge University Press, New York, 1995. xvi, 568 pp., illus. \$110; paper, \$42.95.

Meaningful Differences in the Everyday Experience of Young American Children. Betty Hart and Todd R. Risley. Paul H. Brookes, Baltimore, MD, 1995. xvi, 268 pp., illus. \$22.

Metapatterns. Across Space, Time, and Mind. Tyler Volk. Columbia University Press, New York, 1995. x, 296 pp., illus. \$24.95.

Methods in Plant Molecular Biology. A Laboratory Course Manual. Pal Maliga et al. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY, 1995. xiv, 446 pp., illus. \$110; spiralbound, \$75.

Microbial Physiology. Albert G. Moat and John W. Foster, Eds. 3rd ed. Wiley-Liss, New York, 1995. xviii, 580 pp., illus. \$124.95; paper, \$59.95.

Physics. A World View. Larry D. Kirkpatrick and Gerald F. Wheeler. 2nd ed. Saunders, Philadelphia, 1995. xxvi, 660 pp., illus., + appendix + index. \$58.25. Accompanied by *Physics: A Numerical World View*. 2nd ed. x, 204 pp. Paper.

Places of Inquiry. Research and Advanced Education in Modern Universities. Burton R. Clark. University of California Press, Berkeley, 1995. xiv, 284 pp. \$40 or £32.

Problems in Quantum Mechanics. With Solutions. G. L. Squires. Cambridge University Press, New York, 1995. x, 254 pp. \$49.95; paper, \$24.95.

Pulmonary Vascular Remodelling. Jill E. Bishop, John T. Reeves, and Geoffrey J. Laurent, Eds. Portland, London, 1995 (U.S. distributor, Ashgate, Brookfield, VT). x, 278 pp., illus. \$128 or £80. Portland Press Research Monograph 6.

RNA-Protein Interactions. Kiyoshi Nagai and Iain W. Mattaj, Eds. IRL (Oxford University Press), New York, 1995. xviii, 272 pp., illus. \$98; paper, \$53. *Frontiers in Molecular Biology*.

Science and the Founding Fathers. Science in the Political Thought of Jefferson, Franklin, Adams, and Madison. I. Bernard Cohen. Norton, New York, 1995. 368 pp., illus. \$25.

Sex Determination, Differentiation and Intersexuality in Placental Mammals. R. H. F. Hunter. Cambridge University Press, New York, 1995. xxii, 309 pp., illus., + plates. \$79.95.

Thermodynamics and Statistical Mechanics. Walter Greiner, Ludwig Neise, and Horst Stöcker. Springer-Verlag, New York, 1995. xii, 463 pp., illus. Paper, \$49. Translated from the German edition (1987) by Dirk Rischke.

Thomas Gray in Copenhagen. In Which the Philosopher Cat Meets the Ghost of Hans Christian Andersen. Philip J. Davis. Copernicus (Springer-Verlag), New York, 1995. xvi, 192 pp., illus. \$16 or £23.

Publishers' Addresses

Below is information about how to direct orders for books reviewed in this issue. A fuller list of addresses of publishers represented in *Science* appears in the issue of 26 May 1995, page 1220.

Cambridge University Press, 110 Midland Ave., Port Chester, NY 10573-4930. Phone: 800-872-7423; 914-937-9600. Fax: 914-937-4712.

Oxford University Press, Inc., Order Dept., 2001 Evans Rd., Cary, NC 27513. Phone: 800-451-7556; 919-677-0977. Fax: 919-677-1303.

Wiley-Liss, c/o John Wiley and Sons, Inc., Eastern Distribution Center, 1 Wiley Dr., Somerset, NJ 08875-1272. Phone: 800-225-5945, x2497; 908-469-4400. Fax: 908-302-2300.