

very limited aspects of cerebral asymmetry and makes no attempt to review the voluminous literature on it.

In his first chapter Efron reminds us that the different effects of left- and right-sided brain damage need not imply that the two sides are differently specialized. He uses an analogy suggested by F. M. R. Walshe: If the tooth of a gear in an automobile transmission system has been knocked off, there is a "thunk" every time the drive shaft turns, but one does not conclude from this that the tooth is specialized for preventing thunks. It is true that neurologists and neuropsychologists have often been uncritical in localizing functions in the brain, and Efron's reminder is not untimely. Nevertheless there can be no denying the striking asymmetries of the human brain, even if the concept of hemispheric specialization is itself suspect.

The second chapter focuses on two techniques that have been widely used to study asymmetries in normal people as well as in the split-brained. One is dichotic listening, in which different inputs are fed simultaneously to each ear and an advantage in reporting the input to one or other ear is interpreted as a dominance of the other cerebral hemisphere. For example, a right-ear advantage for verbal material is taken as evidence for a left-hemispheric dominance for language. The other is the visual-hemifield technique, in which visual information is flashed to one or the other side of the point of visual fixation and an advantage to one or other side is again interpreted as evidence for dominance of the opposite hemisphere. Efron is rightly critical of the cottage industry that has developed around these techniques, flooding the literature with low-cost, easy-to-run, sure-fire experiments whose cumulative influence has probably been toward chaos rather than enlightenment.

But in his critique Efron has ignored many of his predecessors. For example, in criticizing Doreen Kimura's "structural" theory of how asymmetries in dichotic listening come about, he points out that attentional biases may play an important role. This was clearly recognized in the early 1960s by Marcel Kinsbourne, and the relative roles of structural and attentional influences have provided what has probably been the dominant issue in dichotic-listening research for nearly 30 years. Yet Kinsbourne is never mentioned.

Similarly, Efron points out that the asymmetries between the visual hemifields may be due to scanning habits rather than to hemispheric specialization, and the role of scanning is explored in some detail in the final chapter, entitled "Life after hemispheric specialization." But again the basic message

is not new. The idea that visual-hemifield asymmetries are due to scanning was the prevailing one in the 1950s, and most of the early investigators were at pains to rule out scanning in arguing for hemispheric differences. To be sure, Efron's work is of some interest in its own right and may force researchers again to take scanning explanations seriously. But, as before, he has ignored earlier, related work by George Sperling, Charles W. Eriksen, and others, as well as the proliferation of recent work on visual attention initiated by Michael I. Posner.

In substance, this book is little more than an extended article summarizing Efron's own work on spatial effects in vision and hearing. The work is often interesting, but for the reader who wants a general update on left brain, right brain dualism the best thing about the book may turn out to be its title.

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## The Bottom of the Sea

**The Deep Sea Bed.** Its Physics, Chemistry and Biology. N. CHARNOCK, J. M. EDMOND, I. N. MCCAVE, A. L. RICE, and T. R. S. WILSON, Eds. The Royal Society, London, 1990. viii, 194 pp., illus., + plate. £ 42.60. From a meeting, London, April 1989.

The deep sea floor and its associated boundary layer have long been perceived as a remote and exotic environment: an ecosystem largely uncoupled from the physical and biological dynamism of the upper ocean. In this view, sunlit surface waters primarily contribute a gentle rain of small, food-poor particles to the cold and dark abyssal reaches, forcing chemical and biological processes at the seabed to proceed at very slow, steady rates. This perception pervades reviews of deep sea research published as recently as 1983. *The Deep Sea Bed: Its Physics, Chemistry and Biology* is not the first publication to dispel the notion of a slow, steady, isolated ecosystem. However, this collection of loosely related papers does highlight a number of research programs of the past decade that demonstrate the deep sea bed to be an integral, and at times dynamic, component of the ocean system.

Three major themes emerge from this collection. The first is that significant physical, chemical, and biological interactions occur between the upper ocean and the deep sea bed on time scales of days to millennia. For example, seafloor "storms" driven in part by surface flows (Richards; Gross and

Nowell), pulses of spring-bloom "phytodetritus" reaching the seabed (Gooday and Turley), and upward fluxes of buoyant particles (Angel) all suggest a surprisingly rapid exchange of energy and materials between surface waters and the abyss. Important interactions between the upper ocean and the seabed are also indicated on longer (thousand-year) time scales by the modeling efforts of Sundquist, which suggest that 40 percent of the ocean's ability to buffer atmospheric CO<sub>2</sub> concentrations is controlled by deposition, precipitation, and dissolution of carbonates in deep sea sediments.

The second major theme of this volume is a corollary of the first; given relatively rapid exchange between surface waters and the abyss, the dynamism of the upper ocean is clearly manifested in seafloor processes. For example, several authors (Gooday and Turley; Jumars *et al.*) outline how the feeding behavior, growth, and reproduction of deep sea organisms ranging from bacteria to brittle stars may rely on rapid utilization of seasonal pulses of food-rich phytodetritus to abyssal sediments. In another paper, Hill and Nowell conclude that large, fast-sinking particles (or "marine snow") may contribute substantially to the clearing of near-bottom nepheloid layers. Because pulses of marine snow are produced during phytoplankton blooms, one might conclude that nepheloid clearing rates may track primary production cycles. Clearly, such linkages between upper ocean dynamics and seabed processes will be intensively studied by deep sea scientists in the coming decade.

A third common thread running through the more exciting papers in this volume is the combination of quantitative models with innovative measurement programs. This is well illustrated in the papers by Emerson and Archer and by Wilson and Wallace, who independently demonstrate that the dissolution rate constant for CaCO<sub>3</sub> in deep sea sediments must be 10 to 100 times smaller than has been surmised from laboratory studies; their findings may have important implications for models of CO<sub>2</sub> cycling in the global ocean. Aller's work also demonstrates the power of combining models with measurements by showing how particle reworking by sediment-dwelling animals (or bioturbation) can dramatically influence the rates and distribution of diagenetic reactions in hemipelagic deep sea sediments. Obviously, many of the physical, chemical, and biological processes in the deep sea are becoming known well enough to model quantitatively; deep sea oceanography has largely passed beyond the stage of simple descriptive work. Major advances are likely to come in the near future from scientists who are able to creatively incorporate their

"deep sea intuition" into quantitative models.

In summary, this volume makes for timely and interesting reading and firmly establishes studies of the deep sea bed in the mainstream of oceanographic research. It does, however, suffer somewhat from the lack of a synthetic chapter; the editors provide little overview of the meeting's goals and conclusions. Nonetheless, it should prove informative to a broad range of ocean scientists and at least provide stimulating browsing for those seeking a glimpse of processes in the most remote, but perhaps not so exotic, ecosystems on the earth's solid surface.

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## Orrery of Orreries

**The Milky Way as a Galaxy.** GERALD GILMORE, IVAN R. KING, and PIETER C. VAN DER KRUIT. Roland Buser and Ivan R. King, Eds. University Science Books, Mill Valley, CA, 1990. xiv, 392pp., illus. \$42.50. Saas-Fee Advanced Course no. 19 (Leysin, Switzerland, March 1989).

Ancient Greeks thought that a jet of milk squirting from Hera's breast across the sky had created the Milky Way. More than two millennia later, 17th-century telescopes resolved the faint glow into myriads of stars. Yet it took photography, an emerging understanding of spiral galaxies, and the discovery of the obscuring influence of Galactic smog to help 20th-century astronomers develop our modern view of the Milky Way: a rotating disk of stars and gas some 150,000 light-years in diameter, in which our sun orbits approximately halfway between the center and the edge and which is surrounded by a vast but tenuous halo of stars and globular clusters.

The position of the sun near the midplane of this disk, and thus deep in the layer of absorbing dust and gas, has bedeviled Milky Way studies from the beginning. How do you study a fogged-in forest from nearby trees? Fortunately, new technologies emerging from two wars have opened new windows at more transparent wavelengths: radio astronomers now study monatomic hydrogen and nearly 100 species of molecules throughout the Galaxy, and infrared cameras pierce the smog to yield our first detailed views of the Galactic center. Yet many classical problems of Milky Way research remain dependent on optical work and suffer from the vast extrapolation necessary to deduce large-scale structure from solar-neighborhood observations. For ex-

ample, we still do not know to within 25 percent how spherical or flattened the Galactic halo of stars is. And after many decades, astronomers still struggle to disentangle the spatial decline of the number density of stars from that of chemical abundances and possibly ages, both of which affect a star's luminosity and inferred distance.

Through this Galactic labyrinth, the authors offer the reader a helpful guided tour. From the volume's jacket, which juxtaposes splendid photographs of the Milky Way and a related galaxy, to its index, they present a comprehensive account of the nature of our home galaxy and its neighbors. They exploit the fact that studies of the Milky Way and external galaxies are complementary: most global properties of galaxies such as shapes, diameters, and rotation patterns are now more easily determined for external galaxies, whereas many detailed investigations of stellar populations—of their chemical compositions, ages, and kinematics—are still possible only within the Milky Way.

A central topic is the gravitational force field generated by 100 billion stars and by dark matter of unknown composition. This field can be deduced from measured motions of stars and gas and yields, in turn, the Galactic mass distribution. The many methods invented during the present century to analyze stellar motions and build mass models are critically reviewed. Despite an enormous amount of astronomers' thought and labor, many fundamental questions remain unanswered. Does a census of all visible matter in the solar neighborhood yield enough mass density to explain the observed stellar motions perpendicular to the Galactic plane, as some astronomers now conclude? Or does the census fall short by a factor of two, thus requiring dark matter in the disk, as Jan Oort pointed out six decades ago and many astronomers still believe? In several lucid chapters on stellar dynamics, the authors lay the groundwork for a future generation of astronomers to grapple with such difficult issues.

The volume originates from 28 lectures given by its three authors. The editors have aptly consolidated these lectures into 16 chapters, for each of which the principal author is identified. A great strength of this outstanding account of our present knowledge of Galactic structure is that it emphasizes historical perspective; it traces the development of ideas, portrays false starts as well as successes, encourages the novice to consult classic books such as the proceedings of the 1957 Vatican Conference (*Stellar Populations*, North-Holland, 1958), and spells out the motivation for ongoing and future investigations in unusual detail. Many of the historical anecdotes will interest first-

year graduate students as well as experienced researchers.

There are also other nuggets to keep the reader's attention, even through technical chapters. How many astronomers would know that the Galactic center currently seen at  $-29^\circ$  declination south of the celestial equator and a main stimulus for building major observatories in Chile, will in 13,000 years' time appear north of the equator at  $+18^\circ$  declination owing to precession of the earth's axis? And did you know that the sun's present position deep in the Galactic smog layer is sheer bad luck? Roughly 90 percent of all disk stars of comparable age reside outside this layer, and even our upward-moving sun will nearly emerge from the smog at about 280 light-years above the midplane—17 million years from now—only to be forced back into the muck by the disk's gravitational attraction. Yet, for some million years earthlings will enjoy a relatively clear view of the Galactic center and bulge.

After reading this volume I no longer see the Milky Way as a labyrinth whose study is daunting but as a grandiose orrery of orreries. From the hustle-bustle of stars in the central cauldron, through the epicyclic ballet of disk stars dancing up and down, to the lone orbits of halo RR Lyrae stars blinking like fireflies in the night, there is a hierarchy of motions too complex to fully comprehend yet beautiful to behold.

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## Books Received

**Advances in Chemotherapy of AIDS.** Robert B. Diasio and Jean-Pierre Sommadossi, Eds. Pergamon, New York, 1990. xiv, 111 pp., illus. \$39.50. From a symposium, Birmingham, AL, Sept. 1988.

**AIDS and the New Viruses.** A. G. Dalgleish and R. A. Weiss, Eds. Academic Press, San Diego, CA, 1990. x, 219 pp., illus. \$66.

**Animal Nutrition and Transport Processes.** Jean Mellinger, Jean-Paul Truchot, and Ibrahim Lahlou, Eds. Karger, New York, 1990. 2 vols. Vol. 1, Nutrition in Wild and Domestic Animals. viii, 289 pp., illus. \$189. Vol. 2, Transport, Respiration, and Excretion. Comparative and Environmental Aspects. viii, 289 pp., illus. \$129. The set, \$286. Comparative Physiology, vols. 5 and 6. From a conference, Reims, France, Sept. 1989.

**Chronic Childhood Disease.** An Introduction to Psychological Theory and Research. Christine Eiser. Cambridge University Press, New York, 1990. x, 174 pp., illus. \$49.50; paper, \$14.95.

**Classification Theories of Polarized Varieties.** Takao Fujita. Cambridge University Press, New York, 1990. xiv, 205 pp. Paper, \$29.95. London Mathematical Society Lecture Note Series, 155.

**A Common Destiny.** Blacks and American Society. Gerald Davis Jaynes and Robin M. Williams, Jr. National Academy Press, Washington, DC, 1989. xvi, 608 pp., illus. Paper, \$19.95. Reprint, 1989 ed.

**Epidemics of Plant Diseases.** Mathematical Analysis and Modeling. Jurgen Kranz. 2nd ed. Springer-Verlag, New York, 1990. xvi, 268 pp. illus. \$98. Ecological Studies, vol. 13. Analysis and Synthesis.

**The Fast-Neutron Breeder Fission Reactor.** G.