Book Reviews

Weak Interactions

Unification of Elementary Forces and Gauge Theories. Papers from a conference, Batavia, Ill., Oct. 1977. DAVID B. CLINE and FREDERICK E. MILLS, Eds. Harwood Academic Publishers, London, 1978 (available in U.S. from P.O. Box 786, Cooper Station, New York, N.Y. 10003). xxii, 770 pp., illus. $39.50

The weak interaction is the force responsible for such diverse processes as nuclear beta decay, neutrino "pressure" in supernovae, and the capture of muons by atomic nuclei. Although it is about 100,000 times weaker than the nuclear "glue" that binds neutrons and protons together, the weak interaction is one of the four fundamental forces of nature, and its study constitutes an important field of elementary particle physics. Several years ago, I prepared a resource letter on weak interactions for the *American Journal of Physics*. In researching the paper, I found that although the "classic" topics, such as beta decay, muon capture, and kaon decay, were nicely and substantially covered by a variety of source materials there existed no single volume that tied together many of the more interesting subjects of recent concern in the field, such as atomic parity violation and astrophysical weak phenomena. *Unification of Elementary Forces and Gauge Theories*, which records the proceedings of a conference held at Fermilab, somewhat fills this need. The forefront topics in weak interactions are all covered, as is evidenced by the section headings: Weak Neutral Currents in Particle Physics, Parity Nonconservation in Atomic Processes, Parity Nonconservation in Nuclei, Search for New Particles Beyond Charm, Weak Interactions in Astrophysics, and Theory.

Since this was a meeting at which nearly all the participants were experts, many of the communications are terse and of only limited utility for a casual reader. Nevertheless, there are a number of papers that are notable for their readability and general interest. Contributions by E. G. Adelberger and D. Tadić are useful summaries of the experimental and theoretical aspects of weak interaction effects as detected in nuclear processes, and the paper by G. Feinberg provides a useful review of our understanding of the contributions of weak interactions to atomic physics reactions. Both of these areas of research involve seeking tiny (one part in a million) weak effects among an enormous nonweak background. However, they offer a unique window to weak interaction structure. Another quite useful review, by C. W. Wu, describes the results of careful studies of nuclear beta decay that have been performed over the last several years and have resulted in a significant improvement in our confidence in the validity of the quark model picture of the weak force.

One of the most interesting sections is that on weak interactions in astrophysics. Papers by D. N. Schramm on supernovae and gravitational collapse, by G. Steigman on the early universe, and by W. A. Fowler on neutrino emission from the sun provide stimulating reading. It has become increasingly clear that weak interactions do have an important role to play in stellar evolution (for example, the coherent scattering of neutrinos is important to the understanding of momentum transfer during the final stage of gravitational collapse). Conversely, astrophysical observations can constrain weak interaction theories—thus, recent studies of the abundance of ^{4}He in the universe have provided a limit on the number of types of massless neutrinos that exist.

In the section on theory, the paper by J. C. Pati provides a useful account of recent progress unifying the basic forces of nature. The contribution by J. D. Bjorken on alternatives to the currently fashionable spontaneously broken gauge models of the weak force demonstrates that only in such gauge models do many of the required constraints on weak interaction theories arise naturally. Thus, to my mind, there is promise that such gauge models really do provide the definitive description of the weak force, although detailed confirmation awaits the detection of the heavy (nearly 100 proton masses) W- and Z-particles whose exchange gives rise to weak effects.

Overall, then, this is a useful volume that most practitioners will wish to own. However, all the contributions assume that the reader is trained in elementary particle physics. The absence of a volume that treats subjects such as those covered here in a form accessible, say, to graduate students remains.

Finally, it would be remiss not to note that this conference was named in memory of Benjamin W. Lee, a theoretical physicist at Fermilab who died at the age of 42 in June 1977 in an automobile crash. Lee was one of the original organizers of this conference, and his work and interests spanned all the topics discussed. This volume is a fitting tribute to him.

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Nonbiological Limnology

Lakes. Chemistry, Geology, Physics. ABRAHAM LERMAN, Ed. Springer-Verlag, New York, 1978. xii, 364 pp., illus. $39.80.

This is an attractive and unusual volume. It contains 11 chapters dealing with many of the topics currently of interest to nonbiological limnologists (and one would hope to biologists as well). Each chapter contains from three to more than ten pages of fundamental material followed by a more detailed discussion of recent advances. This format works exceptionally well, and I would like to see it employed more often.

The book is also remarkable in that most of the 19 authors consider themselves to be not limnologists but geochemists, sedimentary geologists, physical oceanographers, aquatic chemists, or mineralogists. As the number of practicing limnologists has doubled or tripled in the past 15 years, there has been a strong tendency toward specialization, and biological limnologists who consider physical and chemical limnology to be "uninteresting" are becoming increasingly common. One hopes that this book will contribute to a greater appreciation by biologists of the chemical and physical aspects of limnology.

The chapters on the geology of freshwater sediments—sedimentary processes (P. G. Sly); organic compounds (M. A. Barnes and W. C. Barnes); mineralogy and related chemistry (B. F. Jones and C. J. Bowser); carbonate sedimenta-

tion (K. Kelts and K. J. Hsü); and radionuclide limnochronology (S. Krishnaswami and D. Lal)—contain a wealth of information that is simply not available in such concise form anywhere else. Aquatic chemistry is discussed in useful chapters on perturbations caused by humans (W. Stumm and P. Baccini) and chemical modeling of lakes (D. M. Imboden and A. Lerman). The book also treats heat budgets (R. A. Ragotzkie), stable isotopes (F. J. Pearson, Jr., and T. B. Coplen), and saline lakes (H. P. Eugster and L. A. Hardie). The chapter by Eugster and Hardie brings together in one place much of the elegant work that Eugster and his associates have done on highly saline lakes in Africa and North America.

Kelts and Hsü present a useful review of the numerous processes that control carbonate sedimentation in lakes. They have used their own data from Lake Zurich to illustrate most of the major points made in their discussion. This is particularly appropriate because Nipkow's classic work on paleolimnology and sedimentology was done on the varied sediments of that lake. Scanning electron micrographs of selected layers in sediment cores from the lake are used to give one an intimate view of the diatom frustules and minerals deposited through time.

Chemical perturbations by aquatic ecosystems resulting from human activities are examined by Stumm and Baccini in a notably synthetic chapter. The chapter begins with a discussion of the relationship between per capita energy consumption and eutrophication and goes on to deal with chemical speciation and the "emergent" properties of ecosystems. Some sections of the chapter are overly general, but the authors often indicate where particular caution in accepting some of the generalization is required. Many limnologists will be dismayed, however, by the uncritical approach Stumm and Baccini take to ecosystem ecology.

Jones and Bowser treat the mineralogy and related sediment chemistry of lakes in a long, scholarly chapter. They have made a special effort to organize and summarize the current literature in the field (over 230 references are cited). The chapter was written to interest students in the subject and to provide a basic guide to the study and interpretation of the chemical and mineralogical characteristics of sediments as well as to provide a good critical discussion of the relevant literature.

A disappointing chapter by G. T. Csanady on water circulation and dispersal mechanisms is largely a verbatim reprinting of two recent reviews by the same author. Despite an introduction to the fundamentals of this complex subject, which he attempts in a scant three pages, the latter part of the chapter will only be read by people who already have a good grasp of fluid dynamics. Moreover, the chapter deals only with selected aspects of the circulation of the Laurentian Great Lakes and thus many of the physical processes of interest to limnologists working on smaller bodies of water are completely ignored (vertical mixing and Langmuir circulation, for example). A good, readable book on this subject would certainly be a welcome contribution.

Most of the authors have produced chapters that fit nicely into the conceptual framework of the book. The figures and tables are generally excellent, though there is one that I found to be quite incomprehensible (figure 2 in chapter 3). There are some distracting spelling errors, and there are occasionally other errors, such as that Lake Victoria is now located in South Africa. But all in all the book is first-rate.

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Marine Ecology

Upwelling Ecosystems. Papers from a symposium, Kiel, Germany, Sept. 1975. R. BOJE and M. TOMCZAK, Eds. Springer-Verlag, New York, 1978. x, 304 pp., illus. Paper, $27.

The editors of this symposium volume argue that upwelling ecosystems are significant because of their great biological productivity relative to other marine areas and because study of them over the past decade represents perhaps the best development of interdisciplinary cooperation in marine science.

This collection is for those already familiar with oceanography; the reader is abruptly thrust into the terminology (though not the mathematics) of the subject by way of an unsuccessful attempt to define the spatial scales of the phenomenon. Mathematical treatment of physical circulation appears only briefly in J. D. Thompson's discussion of mixing. Specific subjects are handled unevenly; for example, two papers dealing with phytoplankton studied on specific (but different) cruises are followed by a general summary of literature on types of zooplankton in upwelling areas.

In some respects, the editors' intentions are realized. The translation of planktonic production of upwelling regions into the diets of harvestable fish is discussed in two papers (one by D. H. Cushing, who has written often on this issue). There is a good representation of European work (though Russian studies, notably in the equatorial Pacific, are ignored), and, as has not always been the case in volumes on the subject, no particular team or geographical area dominates, though coastal systems receive the most emphasis. Diversity is enhanced by the inclusion of interesting attempts to evaluate the contribution to sediments of the organic remains of plankton stimulated by upwelling and a description of circulation in the Great Lakes. Perhaps of widest interest is a "biopolitical" paper by W. E. Wooster, who castigates researchers for not living up to their pious grant proposals in pursuing more diligently the practical consequences of upwelling.

There are some reports that are mildly interdisciplinary, such as one diagraming the relation between the distribution of the ciliate *Mesodinium* and the general pattern of physical circulation and a good (though brief) treatment of temporal patterns off Ghana. All too rare, however, are syntheses and attempts to state and resolve major issues. For example, T. E. Whitledge assesses the approximate importance of excretion by fish and zooplankton in supplying nutrients and compares these to supply by upwelling and other papers discuss bacteria, but a cooperative, interdisciplinary attempt at a nutrient or carbon budget is not presented. The relation between benthic biomass and food supply from overlying waters is discussed again, but there is little acknowledgment of the fact that many benthic organisms have meroplanktonic larvae that interact directly with the currents and the phytoplankton. Nor is it clearly pointed out that most upwelling areas have major currents flowing through them advecting plankton and nutrients from eutrophic (rich) to relatively oligotrophic (poor) areas.

These criticisms are easy to make and very difficult to obviate; further, it is arguable whether current trends in scientific management and publication will improve or aggravate matters. I would have been more stimulated by this book had the "ecosystem" in the title been better realized, or even delineated, in the contents.

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