researcher. Unfortunately the section is restricted to the Russian literature, and little reference is made to other research in the field.

The specialist in fluid mechanics will already be familiar with the integral methods reviewed by Goodman, but Goodman's analysis of the developments and application of this mathematical technique to heat transfer problems may stimulate further improvements and refinements in the method.

There is some doubt that our knowledge with respect to boiling and two-phase flow has reached the definitive state that justifies the continual rehashing of these fields in books of this type, but any attempt to unify and organize their literature must be applauded. Although a large amount of the literature referred to in the section on boiling has been considered in previous reviews, much updating has been done here. The article, however, reflects the chaotic condition of the literature in the field.

Similar difficulties arise in organizing the literature on two-phase flow, but here the book tends to supplement previous reviews by emphasizing the extensive work performed in various European laboratories, especially those of the atomic energy authorities. The list of references included is particularly thorough.

The book should be useful to anyone engaged in heat transfer research. It is hoped that an equally excellent choice of contributors will be made for any future volumes.

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Geophysics

Paleomagnetism and Its Application to Geological and Geophysical Problems. E. Irving. Wiley, New York, 1964. xviii + 399 pp. Illus. $19.50.

This volume, as the first textbook in English devoted to paleomagnetism, represents an important milestone in the development of a new and rapidly growing field of geophysics. Despite the diversity of its origins, modern paleomagnetism bears the unmistakable imprint of a handful of men who worked in England during the early 1950's, in particular Blackett, Clegg, Hospers, Fisher, Runcorn, Creer, and Irving. The statistical and graphical methods for presenting paleomagnetic results developed by this group are now used universally, and the present reawakening of interest in the perennial geophysical problems of polar wandering and continental drift derives largely from their work. Irving may speak not only as one who has been a leader in framing these larger problems, but also with the authority of an experimentalist who, with his work in Australia, has produced a virtually unequalled body of paleomagnetic data.

One question has often been posed: Is the paleomagnetic evidence for polar wandering and continental drift really conclusive? Many geophysicists remain unconvinced, partly because of the increasing complexity and growing numbers of degrees of freedom of the geophysical models needed to explain all of the paleomagnetic observations in terms of polar wandering and continental drift. The present volume avoids the rhetoric of advocacy but, nonetheless, is a book with the central viewpoint that continental drift and polar wandering are supported paleomagnetically. Discrepant data are attributed to inadequate technique or to intracontinental deformation.

The subjects discussed include magnetic properties of rocks, secular variation, analysis of directions of magnetization, reliability, ancient directions of the field, reversals, intensity determinations, paleolatitudes, and special applications to geology. There is no discussion of apparatus or of methods of calculating magnetic directions. Many subjects are covered by reference to some particular study from the literature which is summarized in clear, concise language with abundant illustrations. The chapter on statistical analysis is outstanding. However, the list of articles covered is large and not especially selective, and the general result, while preserving a good feeling for the original experimental evidence, resembles an extended review article without the fresh, integrated approach that one might expect in a new text.

The author has rendered a great service by compiling paleomagnetic results current to October 1963. He has taken a courageous and an admirable step by indicating results that fail to satisfy reasonable "minimum reliability criteria." There are the inevitable misprints—the description of the study of the Hawaiian lavas, for example, states that directions of remanent magnetization changed significantly on partial demagnetization, whereas the original reference states they did not. But such lapses are rare and perhaps may serve as a reminder that the list is intended as a guide and not as a substitute for consulting original sources.

The most original part of the volume is an extended comparison of ancient paleomagnetic latitudes with various independent indicators of climatic conditions. Sets of observations are found to be consistent only when both the paleomagnetic and the independent paleoclimatic results are based on deposits of the same age from the same area. The occurrence of both polar wandering and continental drift are inferred from this. Compelling evidence for polar wandering is given by the demonstration that in Australia, as the paleomagnetically determined latitude abruptly increased by more than 50° between the Devonian and the Carboniferous Periods, coral reefs disappeared from Australia and glaciations began. No one seriously interested in the problem of polar wandering and continental drift can afford to be unfamiliar with this work.

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Particle Physics

Nucleon Structure. Proceedings of the international conference held in June 1963. Robert Hofstadter and Leonard I. Schiff, Eds. Stanford University Press, Stanford, Calif., 1964. x + 421 pp. Illus. $12.50.

The word nucleon in the book title refers collectively to the particles proton and neutron. Thirty years ago these entities, together with the electron, constituted the full list of the ultimate building blocks of matter. That list has since grown, prodigiously! According to some ways of counting, the known varieties of "elementary" particles now number more than 100. They transform into each other in endless ways—in collision processes and in spontaneous disintegrations of one particle into others. Indeed, the word particle has come to

be applied to unstable entities that persist for as little as 10^{-23} second and whose mass spread, related to lifetime via the uncertainty principle, is an appreciable fraction of the nominal mass itself.

Thus, the building blocks of matter do not appear as the immutable, indivisible objects of ancient thought. Correspondingly, the distinction between "elementary" and "composite" particles has become increasingly blurred. In the opening essay of this volume, G. F. Chew presents the case for the view that all of the subatomic particles have equal claim to being fundamental and that in some sense they should all be regarded as composites of one another. These notions of "nuclear democracy" can be given more precise expression in the framework of detailed mathematical hypotheses, which are at the core of one active line of present-day theoretical research. In any case, so tightly connected are all aspects of particle physics that progress in any one branch of the subject illuminates all of the branches. It is not surprising, therefore, that this collection of papers—there are 70 in all—ranges over a broad spectrum of particle physics, both experimental and theoretical. The papers were presented at the international conference on nucleon structure held at Stanford, California, in June 1963.

At the center of attention is the problem of the electromagnetic structure of the nucleons, as revealed by the beautiful and difficult experiments on electron-nucleon scattering carried out at Stanford, Cornell, Cambridge (Mass.), and Orsay. Roughly speaking, what is measured here is the spatial distribution of electric charge and current densities in the quantum mechanical cloud that constitutes a nucleon. With increasing electron momentum transfer to the nucleon, one explores structure at increasingly small distances. According to present evidence this structure extends smoothly out to distances of order 10^{-13} cm, without any noticeable point-like concentration toward the center. The experimental papers, though short, represent masterful summaries that are still current. On the theoretical side, nucleon electromagnetic structure is, kinematically, one of the simplest of the deep questions of particle physics. It is reviewed in the papers presented by Yennie, Wong, and Durand. Recent progress has been slightly retrograde. The electromagnetic structure is not so completely dominated, as was once hoped, by a few vector meson states; and departures from the standard Rosenbluth constraint on structure, which might have heralded certain bizarre properties of the electromagnetic field suggested by Regge-pole ideas, have failed to materialize experimentally.

A second group of papers deals with high energy elastic scattering experiments and their theoretical interpretation. Especially noteworthy is the excellent review by Lindenbaum of the precision small-angle scattering results obtained at Brookhaven. Special mention must also be made of the paper in which Hughes reviews current sources of knowledge of the electromagnetic fine structure constant and of the paper in which Wu reviews certain critical evidence bearing on theories of nucleon beta decay. In other articles, Rosenfeld, Miller, and Ne'eman discuss the quantum numbers of the subatomic particles and attempt to classify them according to conjectured symmetry schemes.

Altogether, this collection of papers portrays a lively conference on a lively frontier of physics. It concludes with a concise summing up by A. Salam, who also records his judgment of particle physics for 1963 with an appropriate cartoon on the last page of the volume.

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Radioactive Elements

Radiation, Isotopes, and Bone. Franklin C. McLean and Ann M. Budy. Academic Press, New York, 1964. xiv + 216 pp. Illus. Paper, $3.45; cloth, $5.95.

The importance of the skeleton as the site of deposition of certain radioactive elements has been so popularized that the problems created by the "bone seekers" are almost commonplace. McLean and Budy's compact (216 pages) text gives the facts, hypotheses, theories, and conclusions that form the scientific background for these problems in readable, well-illustrated summaries of the pertinent areas of science. This monograph is not an encyclopedia, not for members of the "bone club" only, and not a manual for physicians treating bone diseases. It does provide an orientation on the role of the skeleton in certain health hazards of the atomic age. Definitions are fully stated so that a physicist can appreciate the biological aspects, and a physician the radiation aspects. Informative pictures and tabulations are woven into presentations of concepts. References to papers, reviews, and books are appended to each chapter.

The subject matter of the 14 chapters falls into three categories: (i) The nature of the bone-isotope-radiation problem (chapters 1 to 5). In these chapters discussions couched in understandable language carefully present the pertinent concepts in such diverse fields as atomic structure, radiation physics (for example, the techniques of measuring radioactivity), bones and teeth as tissues, and the nature of the mineral of the hard tissues. (ii) Bone metabolism (chapters 6 to 11 and chapter 14). The important bone-seeking elements and the kinetics of their distribution in the body are described individually in these chapters. Only when one appreciates the homeostatic mechanisms in the normal metabolic processes do the superficial differences fall into a coherent unified pattern. Some isotopes have been used as tracers to reveal the intricate processes of bone metabolism. Clinical applications of isotope techniques can improve the diagnosis of certain pathological states of the skeleton. Metabolic events in the organic part of bone are briefly reviewed. (iii) The effects of radiation on the skeleton (chapters 12 and 13). In this part two matters are considered—the effects of natural radioisotopes, and the effects of nuclear debris, especially the fallout from nuclear bomb testing.

"The properties that lead radioisotopes to seek bone, and to remain deposited therein, have increased both the hazards of radiation and the opportunities to study its effects. This book deals with both topics." College and advanced students in biology, chemistry, and physics, as well as those trained in the health sciences, will find that the complex, interrelated problems discussed in *Radiation, Isotopes, and Bone* are revealed in clarifying perspective.

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