eters of all these interactions between mean and fluctuating motions by means of an eddy viscosity relating local "eddy" stress to local rate of strain, the coefficient may well be negative; it may be meaningless.

The author seeks to interpret many fascinating examples of flow in the earth's atmosphere, the solar atmosphere, ocean circulation, and laboratory experiments in terms of an eddy viscosity. The viscosity is, of course, found to be negative whenever concentrations of flow exist or whenever energy is transferred from smaller to larger scales. For one who understands some fluid dynamics a description of these effects in terms of a negative viscosity is entertaining to read; for others it will surely make them even more mysterious than they are.

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## A Method for Dating

**Thermoluminescence of Geological Materials.** Proceedings of a NATO Advanced Research Institute, Spoleto, Italy, 1966. D. J. MCDOUGALL, Ed. Academic Press, New York, 1968. xvi + 680 pp., illus. $25.

The papers in this volume stem from a 10-day conference at which 62 papers by 72 authors were presented. As is the case with many symposium volumes, the contributions range from trivial to important, and fully half of the papers could have been omitted with no loss to total information content of the volume. The papers can be grouped under the general headings of theory, instrumentation, and applications.

Unfortunately, thermoluminescence theory is today at best a palimpsest, thinly embracing a relatively rich phenomenology and supplying little guide to the successful application of thermoluminescence to geological and archeological problems. Theory seems to provide little explanation for such phenomena as the initially rapid change with time in the rate of depopulation of high-temperature traps, the effectiveness of radiation at high energy levels in the creation of new traps, the relationship between triboluminescence and thermoluminescence, or grinding glow, nor does theory predict that thermoluminescent glow curves should only be measured in an oxygen-free environment. A measure of the lack of theoretical guidance is that many of the authors of the book dismiss portions of signals that are not understood as "spurious."

Unfortunately, the chapters on design and instrumentation are particularly unenlightening. One is cautioned to have an instrument "able to record with high fidelity," that design of the apparatus should be "considered in its broadest overall aspects," and that "properly designed equpiment will provide operational convenience"; one is warned to "avoid the expense of overdesigned functional sections and inadequacies of underdesigned functional sections." In this section one is also informed that "manual control is a method of operation in which the rate is controlled by the operator." We are also told that "a detector is a device which responds to the phenomena being investigated," we are instructed to select a "suitable device," and finally we are told that "the design should accurately tailor the equipment to the measurement needs in every respect."

A substantial number of papers appear under the general heading Applications of Thermoluminescence. A series of papers on geological age determination could be summarized by the single sentence, It can't be done. Thermoluminescence of a mineral is determined not only by its total radiation dose but by saturation of traps, production of new traps with time as a result of radiation damage, drainage of traps, which is a function of thermal history, and the creation and drainage of traps as a function of stress history. It is clear that because of the uncertain history of the average mineral in a geological environment thermoluminescence can give relatively little age information. Even in ideal situations where the thermal history of material is known and most of the variables that can affect thermoluminescence are not operative, such as in recent lava flows, age dating results are not very encouraging. Aitken *et al.* show that the feldspars of the Mount Etna lavas range in thermoluminescence from 0.1 to 90 times the expected glow. Therefore this reviewer cannot agree with the enthusiastic remark of one contributor to this volume that "thermoluminescence can furnish much valuable information about the age of igneous intrusions, faults and metamorphic events."

Dating of archeological artifacts by thermoluminescence seems to be far more promising and on far better ground. Papers by Ralph *et al.* and Aitken *et al.* describe the techniques of archeological age measurements on pottery sherds. In both precision and accuracy, their results do not compare unfavorably with carbon-14 results. It seems likely that in the not too distant future thermoluminescence may become a routine archeological tool.

Unfortunately, it seems likely that many of the other attempted applications of thermoluminescence, such as the determination of paleotemperatures and the determination of geological temperatures, will fail, for the thermoluminescence clock or dosimeter is not sharply set by the event in question, as is the case with the firing of a ceramic pot.

In particular, in this volume the contributions from Oxford by Aitken and his co-workers stand out as of exceptional quality, and they should particularly be read by anyone interested in the application of thermoluminescence to archeological or geological problems.

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## Nucleases and Substrates

**Enzymes in Nucleic Acid Research.** MICHEL PRIVAT DE GARILHE. Hermann, Paris; Holden-Day, San Francisco, 1968. xiv + 393 pp., illus. $16.25. Chemistry of Natural Products.

This volume naturally falls into two separate parts. The first half serves as an introduction to the structure and origin of nucleic acids and analytical methods for studying them, whereas the second half is apparently a revision of the author's earlier book, *Les Nucléases.*

The first part, evidently written so as to make the book conform to the natural products theme of the series, discusses the nomenclature, basic concepts, synthesis, and isolation of nucleic acids. These chapters tend to be written in a confusing style, which often leads to self-contradictory statements and half-truths. To cite only a few examples, on page 29 we are told that there exist three classes of RNA and on page 37 that there are four, and on page 38 a fifth type is discussed. On page 30 we are told that the messenger RNA's are "unstable, since as soon as they have delivered their message, they should

disappear," whereas on page 53 we are told that many mRNA's appear to be stable and have, in fact, been isolated. Furthermore, these chapters are written with a historical approach that tends to cloud current concepts with details of older experiments. In summary, this half of the book is too disjointed for novices to the nucleic acid field, while being too elementary for those familiar with the subject. The same subject matter is more successfully covered in several of the current biochemistry textbooks.

The second half, on the other hand, conforms to the title of the book and is more profitable. Various enzymes of importance in nucleic acid research—albeit only nucleases and phosphatases—are individually discussed with respect to their use as reagents in the study of nucleic acid structure and function. The specificity, availability, and contaminating activities of preparations of virtually all known nucleases and phosphatases are described. A 26-page synoptic table of nucleolytic enzymes—probably the best tabulation of this sort to date—concludes this half. This section of the book should prove to be extremely useful to workers in the field as well as to those in other fields—for example, to geneticists, who are becoming more and more reliant upon these enzymes as specific catalysts.

It is unfortunate that the author chose to append to his treatment of enzymes the introduction to nucleic acids. Perhaps a future edition might instead expand the enzyme theme to include similar descriptions of other enzymes used to study nucleic acids, such as the various DNA and RNA polymerases, polynucleotide kinases, nucleotide kinases, DNA ligases, DNA and RNA methylases, and the DNA glucosylases.

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## Smithsonian and Satellites

**Trackers of the Skies.** E. NELSON HAYES. Doyle, Cambridge, Mass., 1968. xiv + 178 pp., illus. Cloth, $5; paper, $3.

Before the beginning of the satellite programs in 1958, there was a curious and tantalizing situation. Within the United States, or within Europe (or India, or Japan), distances and directions could be calculated with an accuracy of the order of 2 parts in 1 million. However, equal or even shorter distances between points in Europe and points in the United States could be calculated only with a precision of the order of 100 parts per million; and even larger errors were feared. Each large triangulation system was thus like an iceberg, rigid in itself, but with only tenuous relations to other icebergs. There was an obvious military need to correct this situation. In addition, depending on what was supposed about the relations between these icebergs, one could obtain a wide range of theories of the general gravitational field of the earth. Isostasists such as Heiskanen believed that the general field approximated closely that of a fluid in hydrostatic equilibrium; while others, Jeffreys in particular, maintained that there were broad deviations from isostasy, which implied stress differences up to 100 bars deep in the mantle.

The satellite-tracking programs of the last ten years have cleared up this century-old difficulty in a most striking way, so that intercontinental distances and directions are now very nearly as precisely calculated as those within the continental triangulation nets. It has turned out that Jeffreys was right; the field is substantially as he believed and the interior is indeed in a state of stress. In this great advance, the precise optical determinations of the Smithsonian Astrophysical Observatory have had more weight than those of any other program, and very likely more than those of all other programs combined.

This book is a history of the Smithsonian program by an insider, a member of the Cambridge staff. It gives a good idea of the difficulties of the program as seen from within: the embarrassing delays in the procurement of telescopes; the built-in problem of field directors versus central staff; the steady change from a rough-and-ready group of pioneers to a well-organized and precisely functioning system; the public need for information about the program and for participation in it, especially through the Moonwatch program. All of these headquarters-type problems are set out with clarity and humor.

The weak point of the book is in its discussion of the relation of the Smithsonian program to geodesy in general, to other tracking programs, and to investigators who were not at the Smithsonian. The question of intercontinental connections is not mentioned; the utilization of Smithsonian data at U.C.L.A., Tokyo, the Applied Physics Laboratory, and elsewhere is not discussed. The part played by persons outside the Smithsonian in shaping the program is omitted. These omissions deprive the book of a good deal of color, and they deprive the reader of insight into the meaning of the Smithsonian program to the scientific community and the nation.

The book will be of interest to those who have had contact with the tracking problem, whether through the Moonwatch effort or through a relation to mapping or geodesy.

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## Astrophysics

**Principles of Stellar Evolution and Nucleosynthesis.** DONALD D. CLAYTON. McGraw-Hill, New York, 1968. xii + 612 pp., illus. $22.50.

There has been a conspicuous lack of a readable, up-to-date textbook in the related fields of nuclear astrophysics and stellar evolution theory. This book, aimed at the beginning graduate student, goes a long way toward filling that need. Indeed, the initial reaction of students appears to be receptive.

The book is well suited for a two-term course, with equal emphasis on the nuclear and stellar aspects. Three of the chapters are concerned with the former and three with the latter, in addition to an introductory chapter dealing mostly with the observational basis of the subject. Although the order of the chapters does not correspond to this division, they are to some extent independent.

A major merit of this book is that it is easy to read, with a pleasantly high ratio of words to equations. However, mathematical details are usually not neglected if necessary for an understanding of the meaning of a result. The derivations which are included are straightforward and usually in contact with the physics of the situation. Examples are the discussions of sources of opacity and the nuclear Coulomb penetration factor. There are many useful formulas, tables, and figures not easily found in the literature.

One of the few criticisms that may be advanced is the tendency of some