The data reveal distinct organizational patterns of cumulus clouds: in one pattern rows of cumuli are aligned parallel to the low-level wind direction; in the other, the rows are aligned at a considerable angle to the low-level wind. The distributions of these organizational patterns are shown on descriptive charts. A "Whole Sky Code" consisting of 27 categories is proposed by the authors for use in subsequent analysis of tropical cloud data.

The chief deductive results of the study are the conclusions that (i) cloud distribution and structure appear to be controlled by the large-scale planetary flow and (ii) abrupt transitions between organizational patterns of clouds are observed which are evidently related in a sensitive way to the velocity, temperature, and moisture fields. Both of these are consistent with other inferences concerning the tropical atmosphere, and the first confirms the concept underlying the global observation program now being studied by national and international scientific groups.

With great effort and ingenuity Malkus and Riehl have lifted a corner of the veil that obscures the tropical atmosphere, affording a very brief and severely limited glimpse. In almost all respects (except heights of cloud tops and bases) the TIROS satellites now provide much better data in numbers that begin to match the demands of the problem. So I am left with the impression that I have been reading the daily journal written by an early explorer of the unknown new world, full of detail about the geography encountered but in sum providing far less reliable information than one needs to know and far less than is provided on a single page of a modern atlas.

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Textbook on Dynamics: Engineering Aspects

Principles of Dynamics. Donald T. Greenwood. Prentice-Hall, Englewood Cliffs, N.J., 1965. x + 518 pp. Illus. $14.

The author has written an admirable intermediate level textbook on dynamics. Although emphasis is placed on engineering aspects, the book could be used in a physics sequence. The topics covered include dynamics and kinematics of a particle and of a system of particles, orbital motion, Lagrange's equations, rigid body kinematics and dynamics, and linear vibration theory. In the lucid exposition Greenwood maintains a good balance between too little explanation and overmotivation to the point of obscurity. Vector and matrix methods are used throughout, in line with a long overdue innovation in American textbooks on engineering mechanics. Artificial satellites and space exploration have given classical dynamics a rich harvest of new and interesting problems. Not surprisingly, the author has used many of these as illustrative examples and as exercises. We find mention of such things as the "yo-yo" despin mechanism (fortunately without the nickname) and gravity-gradient torque (which provides a natural example of the difference between center of mass and center of gravity).

I found the fundamental chapter on dynamics of a system of particles especially noteworthy. For once the reader is warned that $F = \mathrm{d}(mv)/\mathrm{d}t$ is generally incorrect when m varies! Equations of motion are derived and used for an arbitrary, moving reference point, as well as for the usual fixed or center-of-mass reference point.

Of course, I also found some things not to my taste. The term *tensor* is used superficially and without proper definition; it could have been omitted altogether. The angular velocity of a rigid body is introduced as an almost intuitively obvious concept on page 32 and used freely; on page 330 it is defined. A discussion of Euler or Cayley-Klein parameters would have been welcome because of their newly found importance in computer solutions of rigid body problems.

Finally, the following errata were noted: Problem 5-9 has only the trivial answer $I = 0$, not the answer given in the text. The first of equations (8-308) is incorrect. On page 452 nonnegativeness of the *successive* principal minors (9-33), does not guarantee that V is positive semidefinite; *all* principal minors must be nonnegative.

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Geologic Self-Analysis

The Fabric of Geology. Claude C. Albritton, Jr., Ed. Freeman, Cooper, Stanford, Calif., 1964. x + 374 pp. Illus. $8.

On the first page of the preface we are told that "the very lack of any modern book on the philosophy of geology is justification enough for this work," a statement that not only gives us the principal subject but implies that the philosophy of geology is a neglected branch of the science.

Really, *The Fabric of Geology* is not philosophy as many of us understand that term. Seventeen well-known authors examine questions like these: Can geology be called a science in its own right, or is it only bits and pieces of other sciences, applied to the earth? Does it have "laws and theories of its own"? Is it, uniquely, a historical science? A few of the 17 chapters discuss these matters in considerable detail. Other chapters are peripheral to the central theme; still others confine themselves pretty much to geologic methods, with only tangential reference to philosophic principles.

Paradoxically, the book is wide-ranging and at the same time limited in scope. It is wide-ranging because, in searching for fundamental principles, such diverse fields as paleontology, mineral deposits, geomorphology, and the "historiography" of historical geology are explored. It is rather severely limited by its unremitting search for general geologic laws and theories, which appear to be difficult to find or to formulate.

Who will be interested in geology treated in such limited fashion? Historians and philosophers of science may be expected to take note of a new self-examination in geology, and will look eagerly for general principles and laws by which the science operates. A certain, perhaps small, number of geologists will regard the book as a milestone in geologic thought. The majority will probably put it on the shelf and forget it, or will take it in small doses, at the geologic bedside. A few chapters should make excellent reading for seniors or graduate students; I particularly recommend two chapters—"Rational and empirical methods of investigation in geology" and "Historical science."

Prospective readers should look through the volume, especially at the

preface, which tells why the book was written and what is in it. And they should also glance at the bibliography which includes some 400 titles, each with brief annotation or quotation.

All of us will admire, if not completely share, the authors' enthusiasm for geologic self-analysis.

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Oppenheimer's Lectures

The Flying Trapeze: Three Crises for Physicists. J. Robert Oppenheimer. Oxford University Press, New York, 1964. x + 65 pp. Illus. $2.75.

This slim volume, scarcely larger than a paperback and half as thick, contains the transcript of a recording of the three Whidden lectures of 1962 at McMaster University in Toronto. They were delivered by Oppenheimer from rough notes without manuscript, and they have been edited by M. A. Preston, with some slight rearrangement and the disclaimer that "all the significant words are Oppenheimer's." The lectures are entitled "Space and Time," "Atom and Field," and "War and the Nations."

Those who know the author or have heard him lecture will recognize the flavor of this book as authentic, vintage Oppenheimer. Although the method used to get the book into print gives the words the advantage of spontaneity, it does not always permit easy comprehension: the voice of the lecturer always carries much by intonation and emphasis that does not get through to the printed page without careful rewriting.

The body of the text (pp. 8 to 57) is concerned with making the current concepts of relativity, gravity, nuclear structure, light waves, and the quantum theory—a large order—clear to a general audience, while using an absolute minimum of mathematics and no demonstrations. To do this adequately is a problem that every physicist has met socially, if not professionally, a problem that is always challenging and very rarely met successfully. Surely it was met successfully here, though to state this categorically involves deciding just what is meant by "making things clear" to a nontechnical audience.

The first eight pages are introductory reflections on the history of physical theory and of scientific knowledge in general, a discussion of the tenacity of error, and of the nature of scientific progress. In sharp contrast to them and to the body of the lectures, and of very great historical interest because they are based on the author's own recollection, the last nine pages are the author's "synoptic history" of the developments in nuclear physics that led to the production of atom bombs for use against Japan. Here is also the author's balanced and final judgment in the controversy as to the necessity for using them at Hiroshima and Nagasaki. His concluding paragraph deals with the duty of scientists in relation to the making of a world which will be, hopefully, "varied and cherishes variety, which is free and cherishes freedom, and which is freely changing to adapt to the inevitable needs for change in the 20th century and all centuries to come; but a world which with all its variety, freedom, and change, is without nation states armed for war and above all, a world without war."

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Mathematics

Theory of Difference Schemes: An Introduction. S. K. Godunov and V. S. Ryabenki. Translated by E. Godfredsen. North-Holland, Amsterdam; Interscience (Wiley), New York, 1964. xii + 289 pp. Illus. $9.75.

This volume is an interesting and well-written introduction to the problem of solving ordinary and partial differential equations by replacing the derivatives by difference quotients and approximating the solutions of the resulting difference equations. The authors have written a self-contained volume, avoiding as much as possible systems of references to literature without the book in developing the ideas. A bibliography is given at the end of the book, along with comments on the literature.

No previous preparation in the subject is expected of the reader other than a knowledge of basic concepts such as limits, derivatives, and differential equations, but the ideas involved are by no means simple. All the concepts are developed from elementary notions, and the authors use simple examples to illustrate the points in question.

The first two chapters play an introductory rôle. Here the authors develop the elementary theory of one-dimensional difference equations of the first and second order with constant coefficients, and give precise definitions of approximation and stability. Some of the most commonly used integration schemes, such as the methods of Adams, Stormer, and Runge-Kulta, are bypassed for a single method developed by one of the authors.

In the third chapter, concepts of approximation and stability are discussed for difference schemes for partial differential equations and a scheme for the proof of existence theorems by the method of finite differences given. Some simple procedures for solution of the equation of thermal conductivity are developed in chapter 4.

The last two chapters are devoted to methods that can be used for the study of stability of schemes for the solution of equations which describe nonstationary processes. A method for the study of stability proposed by Gelfand and Babenko is presented; this is combined with the idea of quasi-eigenfunctions leading to the concept of a spectrum of a sequence of operators.

There are a number of appendices that provide an introduction to the literature on various difference methods, including the following papers: "On difference schemes for solution of the equation of thermal conductivity," by Gelfand and Lokutsievski and, by the same authors, a substantial paper entitled "The double sweep method for solution of difference equations"; "The scope of the energy method" by Peter D. Lax; "On the estimate of the amount of computational labor necessary in approximate solutions" by N. S. Bakvalov; and "Difference schemes for parabolic equations and continuous integrals" by V. Y. Krylov.

Although many examples are given in the development of the concepts, the authors provide no problems. This would, of course, be a drawback to the use of the book as a text. Otherwise the book is an admirable one.

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