Explorationist's Guide

Electrical Methods in Geophysical Prospecting. GEORGE V. KELLER and FRANK C. FRISCHKNECHT. Pergamon, New York, 1966. 527 pp., illus. $18.50.

This book contains a great deal of useful information for the explorationist, and in today's market it represents good value indeed. It commences with a review of our present knowledge concerning the transmission of electricity through earth materials, and follows that with a brief discussion of electrical well-logging methods—in about sufficient detail, I would judge, for an exploration course aimed at geophysics and geology majors. Then comes the core material of the book, which is a thorough treatment of the theory relating to the resistivity, magnetotelluric and telluric current, electromagnetic induction, and induced polarization methods of geophysical prospecting, plus enough details of instrumental technique to give the inexperienced reader some feel for practical field problems. A notable feature of the book is the inclusion of many significant contributions made during recent years in these areas by Russian geophysicists.

There is no doubt about the need for a text of this kind. The nearest comparison that would be familiar to most geophysicists in Western countries would, I suppose, be the electrical section in Heiland's *Geophysical Exploration*, which is now over 25 years old, and some of the techniques described therein have long since fallen into disuse. *Electrical Methods* is authoritative and up-to-date, and much of the theory contained within its pages has appeared in the geophysical literature since the last edition of Heiland's book was published. It is also, in general, written for a more advanced audience than Heiland's. About two-thirds of the mathematical material can be handled by junior- or senior-year undergraduates, whereas the remaining third will probably be understood only by geophysicists having some graduate experience. Explorationists will profit from the sections on interpretation theory only after they have properly assimilated the fundamentals, which for the most part are given in sufficient detail that intensive outside reading will not be necessary.

The two best chapters, in my opinion, are those on electrical properties of earth materials and on induced polarization. Both are full of useful information not easily accessible (at least in so well-organized a form) elsewhere in Western geophysical literature; and both, coincidentally, relate to areas in which the authors have themselves made significant contributions. The mathematics in the chapter on telluric currents, which appears to be largely a translation from a Russian work, seemed rather murky by contrast; but this was probably due in part to my lack of familiarity with the subject. The remaining topics are handled carefully, but provide fewer numerical aids for interpretation than might have been hoped for from so specialized a book. There are several errors (probably typographical) in the text, as is perhaps not too surprising in a book containing over 600 numbered equations; but for the most part they are minor ones, unlikely to mislead any careful reader.

It is clear that geophysicists will need a strong academic background in the fundamentals of their science to take full advantage of this book; but for those who are willing to develop this background, it should help very substantially to increase their effectiveness in the field of interpretation. *Electrical Methods* is an important and useful addition to the literature of applied geophysics. In fact, no company or individual who engages in electrical exploration can afford to be without a copy.

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Functions

Lectures on Functional Equations and Their Applications. J. ACZEL. Translated from the German edition (Basel, 1961) by Scripta Technica. Hansjorg Oser, Translation Ed. Academic Press, New York, 1966. 532 pp., illus. $19.50.

This book, an updating of the original edition printed in German, is a welcome and important addition to the mathematical literature. The field of functional equations has mainly been dealt with by amateurs—that is, mathematicians who have developed certain special results cognate with applications to other areas.

Although clues to more general results are indicated, the author stays close to real or complex variables as basic variables for the functions involved. The number of variables and of participating functions is required to be finite. Examples of functional equations are:

$$f(x+y) = f(x) + f(y) \quad (1)$$

$$F[F(x,y),z] = F[x,F(y,x)]. \quad (2)$$

The first is called the *additivity* equation and the second the *associativity* equation. Considering Eq. 2 alone one sees that functional equations, if permitted, go deep into algebraic structure.

The restrictions placed by Aczel on his presentation allow him to start with J. d'Alembert, 1747, as having first given a treatment of functional equations. Euler, Cauchy, Legendre, and Gauss each dealt with certain functional equations. However, N. H. Abel gave the first known general attack on functional equations in a series of four papers published between 1823 and 1827.

The lack of a systematic theory unifying a major portion of what is now known about numerical functional equations lends a rather *ad hoc* appearance to the treatment. The importance of the particular equations considered is so great that one should not require extremes of generality. Anyone working with mathematical analysis would profit by study of this book. Young mathematicians looking for new worlds might well consider the loose ends proposed by Aczel as a place to start.

A most valuable feature of the book is the attempt to provide references to the literature. Although Aczel kindly does not say so, it is obvious that much redundancy exists in the literature, largely because there was no book like the present one to make it less excusable. There is a chronological bibliography by certain years from 1747 to 1965, as well as an author index and a subject index.

The arrangement of the material seems to result from variable classification systems. Thus, chapter 1 is headed "Equations which can be solved by simple substitution," chapter 2 is entitled "Values of the unknown function on a dense set," chapter 3, "Equations with several unknown functions," and chapter 4, "Reduction, general methods," and so on. In other words, sometimes the methods, sometimes the independent variables, and sometimes the forms of the equations are the dominant motive. This seemingly unnatural arrangement reflects the fact that the theory of functional equations has not yet congealed into the framework of tedious elegance.

The treatment in general is adequate for a graduate student of mathematics, and is accessible on a rather elementary level, in principle. In fact the author does not cater to everyone who might use functional equations. His applications are not to kinematics, to economics, to computing, and to logic, but to mathematical analysis. From the standpoint of the research mathematician, the book is a compendium of useful techniques, results, and references. For undergraduate study it needs additional motivation and exercises.

Finally, I consider from my limited viewpoint the question of coverage. It seems to me that inequalities might have been used to better advantage. For example, subadditive functions satisfy a functional inequality. So do convex functions. Embedding the equalities deliberately in inequalities even when emphasizing the former would have definite advantages in techniques, proofs, and generality.

Next, the general principles are often obscured in techniques. I hold to the opinion that a theorem or result is best presented in the most general fashion available, provided this does not generate an unbearable degree of complexity in the conditions. Much of the theory presented holds in a context of partially ordered semigroups or groups. I have discussed several Boolean functional equations which are analogous to certain ones considered here. Such functional equations, implicit in definitions of topology, for example, are not discussed. However, on the grounds he has chosen, those of classical analysis, the author has done a thorough job.

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Elemental Concepts of Science

Philosophical Foundations of Physics. An Introduction to the Philosophy of Science. RUDOLF CARNAP. Martin Gardner, Ed. Basic Books, New York, 1966. 310 pp., illus. $6.50.

Rudolf Carnap is the greatest living philosopher of science in America. He is justly famous for fundamental contributions to formal logic and semantics, the theory of scientific meaning and explanation, inductive logic and probability, and the philosophy of physics. His work is unmatched in scope and significance. It embodies the highest degree of technical precision and has been widely influential in setting standards of exactness in contemporary philosophy of science. His writings, although always models of clarity and thoroughness and much prized by professional philosophers of science, have not often been easily accessible to the general reader.

The present book is a very different sort of work. It is a sustained exhibition of Carnap's talent as an inspired teacher who can make the most abstract technicalities intelligible to the uninitiated. It is the remarkable fruit of collaboration with Martin Gardner, a well-known science writer. Using transcriptions of Carnap's seminar talks on philosophy of physics, Gardner, who had earlier attended a similar course by Carnap, composed the book. Carnap made revisions and checked the accuracy of the manuscript. One has the feeling that the outcome is distinctively Carnap in content and tone. This is a tribute to Gardner's skill and sensitivity. The result is an extremely readable and relatively nontechnical presentation of a wide range of fundamental material in philosophy of science.

The book is actually much broader in scope than its title may suggest. The illustrations are usually drawn from physics, but most of the issues discussed have applicability to all of the empirical sciences—physical, biological, or social. It is mainly concerned with the nature of laws, theories, explanation, confirmation, probability, measurement, and causation. In addition, there are discussions of space, time, and indeterminism in modern physics.

It is a rare and delightful occasion when a great man produces a well-constructed introduction to his field. Until now, we have not had such a book in recent philosophy of science. There have been popularizations and introductory textbooks, but the popularizations have often been contentious and the textbooks have often failed to be elementary. Books of each type have frequently bought simplicity at the price of inaccuracy. The present book does not share these disadvantages. Carnap's views are set forth in clear, intelligible, undogmatic terms; though many may disagree with them, they are serious theses soberly presented. Technical details are often omitted, but supplementation rather than correction is needed to provide the full account. The simplicity has been achieved, moreover, without sacrificing the basic issues. Carnap constantly has his finger upon the essentials, and for this reason the book is elementary in all of the best senses of that term. It is, in my opinion, by far the best book available for the intelligent reader who wants to gain some insight into the nature of contemporary philosophy of science. By virtue of its scope, its accuracy, its penetration, and its stylistic excellence, this book seems likely to achieve recognition as the classic introduction to mid-20th-century philosophy of science.

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Studying Animal Populations

Ecological Methods. With Particular Reference to the Study of Insect Populations. T. R. E. SOUTHWOOD. Methuen, London; Barnes and Noble, New York, 1966. 409 pp., illus. $13.50.

Southwood, who is reader in insect ecology at the University of London, has given us an excellent book, one which should be of lasting value to ecologists. One of its important features is that the large and scattered literature in this field has been gathered and analyzed critically. There are 14 chapters. Following an introduction, the sampling program and measurement and description of dispersion are considered. This is followed by a series of chapters dealing with absolute population estimates: by use of marking techniques, and by sampling a unit of habitat (air, air plants, plant products and vertebrate hosts, soil and litter, fresh water). Then comes a chapter on methods for relative population measurement and for derivation of absolute estimates. Estimates based on products and effects of insects are considered. Both observational and experimental methods for estimating natality, mortality, and dispersal are examined. Construction, description, and analysis of age-specific and time-specific life tables occupy two chapters. The construction of life tables is done in such a manner that only a modicum of background experience is needed to understand the procedures. These chapters are followed by a short one on the experimental component analysis of population processes. Then a much longer chapter on