BOOK REVIEWS

Radio Wave Propagation and the Ionosphere. Ya. L. Al'pert. Transl. from the 1960 Russian ed. 394 pp. Consultants Bureau, New York, 1963. $22.50. *Reviewed by Howard Chang, Stanford Research Institute.*

IN 1901, in an epochal experiment in which he succeeded in sending radio waves from Cornwall to Newfoundland, Marconi initiated transoceanic wireless communication and founded a new branch of physics, ionospheric physics. Theoreticians immediately attempted to explain the unexpected long-distance transmission as due to the diffraction of the radio waves by the spherical earth. However, even the most ingenious calculations failed to explain the "anomalous transmission" on this basis. In 1902, Kennelly in America and Heaviside in England independently postulated the existence of a conducting spherical layer in the upper regions of the earth's atmosphere and postulated that this layer deflects the radio waves and forces them to follow the curvature of the earth. Heaviside also made the seminal hypothesis that the conductivity of the ionosphere is due to the presence of positive and negative ions produced by the ionization action of solar radiation. However, the first direct evidence of the existence of the ionosphere, the spherical layer of tenuous, slightly ionized plasma extending from about 50 km to 500 km, came only in 1925, when Appleton and Barnett, by comparing the intensities of fading signals received simultaneously on two properly oriented antennas, proved the existence of the sky (indirect) wave coming down after reflection from the *E* layer. A year later, Breit and Tuve performed their classical experiments by the so-called group retardation method in which they measured the time interval between the arrival of the ground (direct) wave and the sky wave. Since then, the literature on the ionosphere and the propagation of electromagnetic waves in it has steadily grown to a truly impressive size. With the added impetus provided by the IGY (1957–58), it continues to grow at an alarming and vertiginous rate. Thousands of people are currently working in ionospheric physics, and entire journals and societies are devoted to furthering our knowledge of it.

The most widely used (and now obsolete) references in this field are Mitra's *The Upper Atmosphere*, Rawer's *The Ionosphere*, and Bremmer's *Terrestrial Radio Waves*. Another valuable but somewhat more obscure reference has been the Russian monograph, *Propagation of Radio Waves* by Ya. Al'pert, V. Ginzburg, and E. Feinberg. In a certain sense, Al'pert's new book is a revised modern edition of the latter monograph of which only certain sections were available in English. With this splendid book, Al'pert firmly establishes his claim as one of the foremost experts in ionospheric physics. The labor of love shines through its pages, and were it not for the ephemeral and incomplete nature of the morphology of the ionosphere and the nature of its formation, it would undoubtedly become a classic. Richly supplied with over four hundred clearly labeled and easily read figures and tables, it represents the best single, modern source on radio-wave propagation and the ionosphere. The data presented include much new information obtained by rockets and satellites for previously inaccessible regions of the upper ionosphere. The presentation is invariably accompanied by a clear explanation of the experimental technique and a simple, physical interpretation of the results. The printing is clear and easy to read.

The arrangement of the material and choice of topics are logical and sensible. Part 1 is devoted to the ionosphere. Topics such as the morphology of the ionosphere, its formation, regular variations in the electron density, the effective collision frequency and irregular phenomena in the ionosphere are treated imaginatively and clearly in two hundred pages. The second half of the book is devoted to radio-wave propagation and begins with a chapter on the general laws of radio-wave propagation. The radio spectrum is then divided into five regions: (a) long wave, 20 000 to 2000 m; (b) medium waves, 2000 to 200 m; (c) short waves, 200 to 10 m; (d) ultrashort waves, 10 m to 50 cm; and (e) microwaves, 50 cm to millimeter waves; and a separate chapter is devoted to propagation in each of these regions.

The mathematical maturity required to read the book is minimal. An elementary course in differential equations and a junior course in electromagnetic theory is sufficient. Considering the wealth of material and the general excellence of this fine example of Russian scientific scholarship, it is not overpriced. Its value would have been enhanced greatly if the translators had provided an index, which Al'pert, like so many other Russian authors, failed to include. In extenuation, it must be added that the excellent short paragraphs at the beginning of each chapter almost serve as an index. Additionally, a glossary would have helped to make the book more easy to read. The detailed bibliography is an excellent and modern one.

Electromagnetism and Relativity. By E. P. Ney. 147 pp. Harper & Row, New York, 1962. Paperbound $3.75. *Reviewed by W. S. Bickel, Pennsylvania State University.*

THE general feeling about relativity by undergraduates approaching it for the first time is one of awe and mystery, and it seems there is a general lack of sympathetic teaching of relativity on this level. The student's first contact with it is either a rather qualitative one involving confusing discussions about simultaneity and clock synchronization, or he is given an apology and told that only after development of more sophisticated mathematical machinery will he be ready for relativity; later on, he is apt to be overwhelmed by the complexity of mathematical language which tends to hide the simplicity and consistency of its axioms. A lot of students never will have an occasion to develop the mathematics needed and therefore should not be denied the chance to understand and appreciate the far-reaching effects relativity has had on our basic concepts of space and time.

The use of this book does not demand tensor or vector analysis; it does not demand a knowledge of differential geometry, but it does require a respectable use of the student's available background in calculus and elementary physics. It is important to note that in this respect it does not have the usual relativity-made-easy-for-the-layman approach that is typical of so many introductory books. *Electromagnetism and Relativity* is written for second- or third-year science students, and it is for them this book is recommended.

The introduction to relativity via electromagnetic theory is rather natural, and the need for relativistic invariance is shown in sections starting with a discussion of coordinate systems and wave motion through Maxwell's equations to the Michelson-Morley experiment. In the second chapter on special relativity, the conventional relations involving energy, momentum, and mass are derived without the usual confusion as to which coordinate system is which. Chapter 3 treats general relativity, and Chapter 4 deals with calculations of the general relativistic effects. The fifth and last chapter consists of sixty-three elucidative problems.

An important feature is the continual indication of the magnitude of the relativistic effects and the accuracy of confirmation of the different predictions of the theory. Especially interesting is the discussion of the various solutions to the twin paradox and the experimental tests of the general theory. With due respect for the capabilities of the reader, the author uses a few of the implications of general theory to derive Einstein's cosmology.

Introduction to Microwave Theory. By H. A. Atwater. 244 pp. McGraw-Hill Book Co., Inc., New York, 1962. $8.75.

The Wave-Guide Mode Theory of Wave Propagation. By K. G. Budden. 325 pp. (Logos Press, London) Prentice-Hall, Inc., Englewood Cliffs, N. J., 1961. $16.00. *Reviewed by H. J. Hagger, Albiswerk AG, Zürich, Switzerland.*

THE growing interest in the use of electromagnetic waves guided by boundaries or metallic walls has created a demand for specialists familiar with the problems involved; at the same time, the discovery of unusual wave-propagation methods has led scientists to ask for new and unified propagation theories. Atwater's *Introduction to Microwave Theory* is the product of a one-semester course in the field. It covers transmission-line theory, Smith-Chart application, wave propagation in rectangular, circular, and coaxial waveguides, and it contains a very well-written chapter on multiport junctions, a topic not often considered essential in an introductory book. The author also deals briefly with microwave generation and amplification by klystrons, magnetrons, and traveling-wave tubes, and with the behavior of ferrite materials in the microwave field and its application to rotators, isolators, and magnetic-parametric amplifiers. An introduction to problems of millimeter waves is included. Atwater's book may well serve as a guide to an introductory course in microwave theory, and both teacher and student may find the problems appended to each chapter to be valuable exercises. However, since the topics covered in this book are not by themselves sufficient for a full understanding of microwave problems, this volume should be supplemented either by the study of other books or by attending a course in microwave theory. The book gives a good, if brief review, of the problems involved, but fails to be a complete guide to the most necessary measuring techniques and to component design in the microwave field.

Budden's *Wave-Guide Mode Theory of Wave Propagation* serves a completely different purpose. It is written for the wave-propagation specialist and it demonstrates extremely stimulating and valuable parallels between the guidance of electromagnetic waves between the earth and higher atmospheric layers and the propagation of underwater sound waves between the surface and the bottom. Even though the main emphasis of the book is put on the electromagnetic wave, Budden draws parallels to other, more complicated wave motions. Starting with propagation in metallic waveguides, the author deals with effects in stratified and lossy media, as well as the influence of the curvature of the earth and of imperfect boundary conditions on wave propagation. The phenomena of abnormal range of very-high frequencies and surface waves are also treated. In spite of its purely mathematical basis, Budden's book is easy reading and extremely useful for the understanding of long-range radio and underwater sound propagation. The specialist will—after a careful look—not only enjoy the value of the unified propagation theory and the way it is developed, but will want to have the book handy on his desk, for it shows him new aspects, new parallels, new links in wave physics in a very unusual, but well-presented way. The reader will also find lists of symbols and subjects and very helpful references.

Gravitation: An Introduction to Current Research. Louis Witten, ed. 481 pp. John Wiley & Sons, Inc., New York, 1962. $15.00. *Reviewed by Jacques E. Romain, General Dynamics*/Fort Worth.

ALTHOUGH general relativity is nearly half a century old, the difficulties associated with the physical interpretations of its beautiful mathematical formalism are far from clarified. The extensive work that has been under way recently has led more to the dis-