BIBLIOGRAPHY

H. Bethe and P. Morrison, Elementary Nuclear Theory. Russian translation from English by O. A. Vladimirova. Edited by V. B. Berestetskiĭ. IL, Moscow, 1958.

This interesting book by Bethe and Morrison attempts to present the basic concepts of nuclear physics from the point of view of the theory of nuclear forces. The book consists of three parts. The first part, "Descriptive Theory of Nuclei," contains a brief summary of the main factual data on the masses, sizes, spins, and statistics of nuclei, and also on nuclear transmutations and mesons. The presentation is very concise, in the style of a handbook. The second part, "Quantitative Theory of Nuclear Forces," is the main part of the book, both as to volume (about 150 pages) and as to interest. Its main subject is the two-particle interaction of nucleons: the theory of the deuteron and the scattering of neutrons and protons by protons. An outline of the meson theory of nuclear forces is given in the brief space of 10 pages. The third part, "Complex Nuclei. Beta Decay," contains the topics of greatest importance for applications: the liquid-drop model, the Fermi-gas model, the shell model, and the generalized model; the theories of nuclear reactions and of beta decay. Only about 100 pages are devoted to this enormous amount of material. An appendix contains some tables for reference and the usual table of isotopes. Unfortunately there is no alphabetical index, and in view of the somewhat unusual arrangement of the material this is a decided handicap in using the book.

The book is written on a very high scientific level, and a translation of it is certainly of value. The book takes in a very wide range of problems, and despite its small size, includes essentially all the problems of present-day nuclear physics. At the same time, an examination of this book and of the translation leads to a number of critical remarks.

First of all, the adjective "elementary" is scarcely suitable here. It would be more accurate to say "brief." The authors do not present detailed proofs, and omit intermediate developments; but this of course does not make understanding easier — rather the reverse. The more detailed books of Blatt and Weisskopf and of A. S. Davydov are actually much easier to read, and a reader without extensive preparation will often have to turn to them not only "for a more detailed account," as is said in the preface to the translation, but also for explanations of a number of difficult passages. It is of course possible to combine small volume with exposition useful to a wide circle of readers, but this necessarily means restricting the choice of material, as has been done in the brilliant book by L. D. Landau and Ya. A. Smorodinskiĭ, Lectures on the Theory of the Atomic Nucleus, which is undoubtedly the best introduction to the study of nuclear physics. The book by Bethe and Morrison is more suitable for a reader with previous preparation, as a second course or a reference aid. It is difficult for a beginner.

Though certainly interesting, the general position of the authors of this book seems disputable. The present development of science has shown rather clearly that the theory of the nucleus cannot be regarded as a direct outgrowth from the theory of nuclear forces acting between individual nucleons. Such ideas as the liquid-drop theory and the theory of the compound nucleus, the shell model and the generalized model, and such methods as those of the present theory of collective interactions — all of these have proved more fruitful than the frontal attack on the law of elementary interaction between nucleons. In this book, however, disproportionately little space and attention has been given to all these matters. The effort to obtain everything as a logical development from ideas about nuclear forces leads to many departures from a logical arrangement of the material. For example, the fundamental idea of isotopic spin has been put in the section on "Saturation of Nuclear Forces," and the question of quadrupole moments has been scattered through several different sections. This book has not provided the final solution of the problem of a brief introduction to nuclear physics written from a fully up-to-date viewpoint. Further work in this direction is desirable, with the participation of Soviet authors.

Although quite competent, the translation in places shows insufficient care. One passage that can be confusing is: "The existence . . . of intrinsic magnetic moments changes somewhat the usual classical treatment of currents associated only with the motion of particles, but in most cases the change is small, except for cases in which the intrinsic moments tend to increase the strengths of magnetic multipoles by a sizable factor" (page 271). In the original it is stated that the treatment which is changed is that which takes into account only the currents associated with the motion of particles (the treatment of these currents themselves is of course not changed at all), and there is no singling out of vague "exceptional cases"; it is simply stated that the strengths of the magnetic multipoles are increased. On the next page the reader learns with surprise of the existence of a "special apparatus" for determining the multipole character, and may feel a temptation to order it from an instrument manufacturer. The original speaks not of an "apparatus," but of special methods.

There are obvious crude mistakes in Eqs. (20.12a, b) and in the formula for the quadrupole moment on page 225. The original can be blamed for these: in the first case the mistake arose from lack of care in dealing with the writing of fractions with a slanting stroke, commonly used in the American literature; in the second case there is an obvious misprint in the original. This does not, however, relieve the editors of the translation of responsibility for the reproduction of obvious misprints, which are at once evident to any reader familiar with the subject. Here there has clearly been carelessness in the editing of the translation. The translation of scientific literature is a difficult task, and imposes particularly great responsibility on the editor.

— D. A. Frank-Kamenetskiĭ

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Translated by W. H. Furry

V. N. Shevchik, Основы электроники сверхвысоких частот (Fundamentals of Microwave Electronics), Edited by A. I. Kostienko, "Soviet Radio" Press, Moscow, 1959, 306 pp, 8.5 rub.

In recent years a number of books devoted to problems of microwave electronics have appeared in the Soviet literature.

Fundamentals of Microwave Electronics by V. N. Shevchik differs from these in the nature of the presentation and in general approach. It is a good textbook and will also be useful for the specialist, being intended for students, engineers, and radio physicists.

In this book the author has made wide use of his own original work, based chiefly on the kinematic (i.e., energy) analysis of the klystron, travelling wave tube (TWT), and backward wave oscillator (BWO).

This method, which is essentially a first approximation to the problem of finding self-consistent solutions for the mechanical equations and the electromagnetic-field equations, permits a simple approach to the problem of calculating the important parameters in microwave devices (gain and efficiency of the TWT, starting current of the BWO, efficiency of the BWO etc.). The effect of space charge in these devices is then introduced as a correction to the expression obtained in the kinematic approximation.

In this approach, the convection current is first computed for a given field; then the time average of the power associated with the interaction between the current and the field is found.

Values of the parameters for which this power is negative correspond to excitation of the system, i.e., the transfer of energy from electrons to the field.

The energy analysis of devices such as the TWT, in which there is an extended interaction between the electron beam and the field, was developed in 1946-1948 by S. D. Gvozdover and his colleagues. Similar analyses were carried out independently by V. N. Shevchik, who extended the technique, showing that the basic experimental characteristics of the TWT and the BWO are in good agreement with the results obtained with this approach.

A welcome feature of the book is the fact that the extended calculations usually found in books on microwave electronics have been omitted. Instead, the author indicates the general nature of the calculations and then gives the final results; the physical significance of the results is discussed in detail.

This book is characterized by a systematic presentation and offers extremely useful explanations of the operation of a number of new devices (for example, the magnetron amplifier, carmatron, dichotron, mitron, strophotron, etc.).

The book consists of seven chapters and is divided into three sections. Chapter I contains a brief presentation of the circuit elements used in microwave electronics: cavity resonators, characterized by narrow bandwidths, and periodic slow-wave structures, which are broadband systems.

Chapter II is devoted to basic electronic effects at microwave frequencies; these include modulation and bunching of electron beams and cascade bunching.

In Chapter III the interactions between electron beams and alternating electric fields are analyzed.

In this chapter the power developed in the interaction between an electron beam and the field associated with a travelling, exponentially increasing wave is found. This result is used in the energy analysis of the TWT.

A brief discussion is given of M -type systems (crossed electric and magnetic fields); amplification of the space charge wave by variation of beam velocity and a number of other problems are also considered.

Chapters IV, V, VI, and VII are devoted to a brief description of the design and characteristics of microwave devices whose principles of operation are given in Chapters II and III. In this section the author considers narrow-band systems (two and three-resonator klystrons, monotron, travelling wave klystron, reflex-klystron oscillator, reflex-klystron frequency multiplier, etc.) and broad band systems (TWT, magnetron amplifier, TWT oscillator, O -type and M -type BWO, carmatron, etc.).

Electron-wave devices (two-beam amplifier, potential jump amplifier, resistive-wall amplifier, dichotron, mitron, strophotron) are considered in Chapter VII.

The author has been successful in giving a clear picture of the principles of operation and design of the important microwave electronic devices. The book is also well edited.

Several remarks, however, may be in order:

1. Although the approach used is based on the calculation of the power in the interaction between beams and fields, the author does not give the basic theorem which describes energy flow in a beam. This theorem, which is frequently called the kinetic power theorem when applied to linear processes, furnishes a basis for understanding a number of features of energy flow in a beam.

2. The description of energy flow in an electron beam in the drift space of a two-cavity klystron (cf. p. 92) is somewhat inaccurate. Speaking of drift space the author writes: "the variable part of the beam energy (for any value of x) is the energy acquired by the electrons by virtue of velocity modulation upon entrance into the drift space."

However, it should be kept in mind that the energy required to velocity modulate the beam is zero when averaged over a cycle. The average flow of energy through the drift space is zero. A fast wave and a slow wave are excited in the beam and these carry positive and negative energy respectively.

The fast wave contains the excess (compared with average) kinetic energy of the electrons, which is converted into electromagnetic field energy at the output resonator; the slow wave remains in the beam beyond the output resonator and is to be associated with the reduction in the kinetic energy of the electrons as compared with the average value.

3. The expression for the harmonic current components in travelling waves of fixed and increasing amplitude should be derived in more logical fashion.

4. The synchronism principle given by the author (cf. p. 105) is unnecessary. Usually, in the theory of the TWT, synchronism is taken to mean that the mean velocity of the electron beam and the velocity of the cold wave in the system are the same. In considering the field associated with the space charge in the beam—slow-wave system, three forward waves are considered; two of these have velocities slower than the electron beam. One of these waves increases exponentially and carries the negative kinetic power and is responsible for the growing wave in the slow-wave system. For the growing wave the beam velocity is always greater than the wave velocity even if synchronism exists between the mean velocity of the beam and the velocity of the cold wave.

5. The substitution $\tau = \frac{1}{2} i$ in §43 is not strictly accurate and for this reason all the following formulas are only approximate. There is no comparison of the approximate analysis with more complete non-linear analyses of the TWT, such as that developed by L. N. Loshakov as far back as 1955.

6. It would be desirable to supplement the bibliography of the book by a list of recent papers devoted to the non-linear theory of the TWT, the non-linear theory of the BWO and the problem of minimizing the input noise of the TWT. The information given in §43 is more or less out of date.

These remarks, however, are not intended to detract from the merits of the book, which is an excellent textbook for students and which should be valuable for radio physicists as well as other specialists in microwave electronics. There is no doubt that the book will be read with great interest by many engineers and scientists.

— V. M. Lopukhin
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Translated by H. Lashinsky