expanding. Assuming the rate of expansion to have been the same in the past, the present universe must have expanded from a state, which would have had the density of nuclear matter, about 1.7×10^9 years ago. It is this state, called the ylem, which is regarded as the primitive condition from which the universe is developed. The ylem is regarded as a nuclear gas at a temperature of many thousands of millions of degrees. In this gas protons, neutrons and electrons co-existed in a dynamical equilibrium. As the gas expanded, it cooled and nuclear synthesis began. The author claims that, by discussing the dynamics of the nuclear reactions involved, it is possible to understand the abundance distribution of the elements, which is significantly similar throughout the universe.

Having described the first hour of the embryonic universe, Prof. Gamow then considers the processes which led, through the course of a few hundred million years, to the structure of the present universe with its stars and galaxies. In the course of this he discusses many aspects of astrophysics, such as the sources of nuclear energy in the stars, which are quite well established and of great interest.

The whole book is written in a most pleasant style, and it presents a coherent argument throughout. For the professional physicist and astronomer it is well worth reading for the excellent way in which new ideas are presented and the outlook of modern physics employed. For the student or the layman it should make fascinating reading, as it is in no sense technical and has the largest possible horizon.

H. S. W. MASSEY

ELECTRON OPTICS: PURE AND APPLIED

Electron Optics

By Prof. O. Klemperer. (Cambridge Monographs on Physics.) Second edition. Pp. xiii+471. (Cambridge: At the University Press, 1953.) 50s. net.

IN describing this book one cannot help recalling the well-known lines about books written by Bacon in his "Of Studies": "Some books are to be tasted, others to be swallowed and some few to be chewed and digested". Bacon would no doubt have agreed that all three categories could have been accommodated in the one book under review here, for it caters for three separate types of reader—physicists working in fields other than electron optics, those engaged in electron optical design, and those actively engaged in this research field and pondering over its problems.

Before discussing how the book meets these needs, it is as well to trace its origin and purpose. The monograph on "Electron Optics" appeared as a Cambridge Physical Tract in 1939. At that time the subject as such had been recognized as a new and developing branch of 'electron physics' for about a decade, and its general basic principles had been formulated. These had been stated with conciseness and clarity in the first edition; so much so, in fact, that it formed an excellent introduction to the subject for all those engaged in research and development work involving the principles of operation and design of electron devices of many kinds. Since that time the importance of the subject has been widely recognized in both academic and industrial fields, and a considerable volume of work has appeared,

enlarging upon and extending the field of application. The extent of this development can be gauged by a comparison between the first and the present second edition, in which the book has expanded to approximately six times its original size and includes some five hundred references to original papers.

The task of co-ordinating so extensive a field is no easy one. It requires a great deal of selective judgment and critical ability on the part of an author, as well as an exceedingly wide acquaintance with fundamental work in borderline fields; these are necessary in order to present the subject with coherence and unity. These qualifications are happily to be found in Prof. Klemperer, who has himself contributed a large amount of important work in the subject of which he writes.

While it can generally be said that the pattern of the subject-matter has now become formalized, yet the author introduces and develops many topics in an original way; in many instances there is evidence of an individualistic outlook which is highly stimulating to those actively engaged in research. The great merit of the book is that, as stated earlier, it can be used profitably by all types of worker. The novice will find a clear description of all the basic properties of focusing fields—electrostatic and electromagnetic—as well as their defects, treated mainly from the experimental point of view. The initiated will welcome good discussions on the effects of space charge on round and flat beams and fields, as well as a separate chapter under the heading of "Emission Systems" which deals adequately with the important characteristics of 'electron guns'. The chapter on emission systems with line focus brings to the reader's notice the characteristics of recent developments on 'box' and 'double lipped' lenses and their application to the design of X-ray tubes, triode and beam power valves and photomultipliers; while that on 'deflecting fields' will be of special interest to television engineers because of the detailed treatment of inherent errors and their correction.

The experimental physicist engaged on problems of 'separation analysis' will find much useful information on cylindrical and spherical condenser focusing systems, as well as on the properties of magnetic sector fields, and mass and beta-ray spectrometers (their dispersion and resolving power).

The final chapter, on applications in industry and research, is in a sense a consummation of all that has gone before, for it gives an account of the various fields in applied physics enriched by the application of knowledge of principles established earlier. Here are to be found clear descriptions of such important devices as television pick-up tubes, scintillation counters, image converters, electron microscopes, electron accelerators, storage tubes, etc.

On the whole, the book is authoritative and shows a good balance by skilful blending of the old and new. It gives a just emphasis to those topics which are in process of development, indicates and assesses the importance of complicating factors in interpreting fundamental results and will have the effect of stimulating the more advanced worker in his researches. It also carries much useful information in the form of curves, for the designer of systems who requires them to have a certain 'quality'. It has a good index and copious references to original sources. The latter could be improved in the bibliography by giving the page number in place of the chapter.

L. JACOB