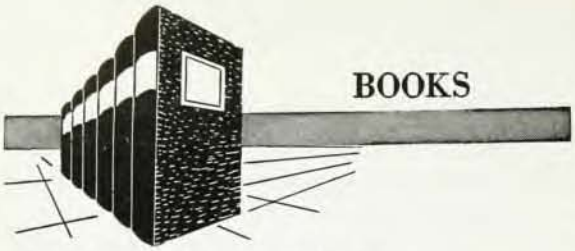

Goethe and Newton

PHYSICAL ASPECTS OF COLOUR. By Pieter Johannes Bouma. 312 pp. N. V. Philips Gloeilampenfabricken, Eindhoven, 1947. Elsevier Book Company, New York. $5.50.
VISION AND THE EYE. By M. H. Pirenne. 187 pp. The Pilot Press, Ltd., London, 1948. 12/.6d.

"Whatever is visible is color. . . . It is only in light that the color of a thing is seen. Hence, our first task is to explain what light is." Thus did Aristotle write the program for the science of color, twenty-four hundred years ago. The subject of color is little understood today, but not because it has been neglected or because only incompetents have concerned themselves with it. DaVinci, Newton, Goethe, Schopenhauer, Thomas Young, Dalton, Grassman, Maxwell, Helmholtz, Ostwald, and Schrödinger each contributed significantly to the subject during periods of great creativity.

Nor is color little understood because there is little interest in the subject. Any lecture on color is well attended. The popular press is avid for articles on color and so, apparently, are publishers of books. From this we can judge safely enough that there are many people willing to read and to buy discussions of color. Can it be that color is poorly understood because there have been so many renowned authorities and no one of comparable stature to unify contributions of all? Or is color perhaps such a vividly intimate experience for each of us that we cannot be satisfied with any scientific account?

The strongest feature of Dr. Bouma's book is the account of the history of the science of color. This is not confined to the chapter on that subject but appears frequently throughout the book when old concepts, left general and unquantified by their originators, are clarified on a uniform basis in quantitative terms. Thus, the degree of impurity of Newton's first spectrum is shown, which reveals the origin of discrepancies between Newton's results and modern data. Newton's fruitful analogy of color mixture to a center of gravity is stated in terms in which it is precisely correct, not indeed for the first time, but in a manner that should make it less mysterious and a more familiar tool than in the past.

It is Goethe's antipathy towards the dispassionate study of light and color which seems to have been the origin of much of the confusion characterizing the subject of color today. "Newton, an experimental physicist if there ever was one," Bouma writes, "took the view that, quite independent of the observer, there exists a great system, the nature and behavior of which is regulated by strict laws, and he made it his purpose to discover some of those laws, a task in which, as we all know, he was extraordinarily successful. To study these laws one must set to work as objectively as possible and eliminate as far as possible the individual properties of the observer. This conviction is at once seen reflected in his first experiment. He admitted the light of the sun—the origin of everything—into his room through a small hole and let it pass through a prism so that a spectrum was produced on the opposite wall. He put the light to all kinds of tests, as it were, in order to discover something of its nature, and himself stood on one side as an interested but objective and unbiased examiner.

"How differently did Goethe face the problems! For him man was always the starting point; in this particular case the subjective colour sensations received and the numerous and divergent sensations they evoked in his fine artist's mind. The purpose of his investigations was to discover how these impressions originate and how they are influenced by circumstances. Typical of his point of view is his first experiment. He placed a prism before his own eye and observed through this first of all a white wall and after that a vertical division between a light and dark surface, etc. In a sense he was not the examiner but the examined!"

Goethe constructed a self-consistent system of color classification on the colors seen by looking through a prism at the boundary between black and white areas. These colors are specified by Bouma in the quantitative terms customarily used today in color measurement. Related to Goethe's boundary colors and perhaps springing from the seed planted by him are the full colors of Ostwald which are also represented in modern terms by Bouma. Munsell carried Goethe's artistic rejection of physical analysis to completion and developed a system of color classification based almost entirely on the subjective qualities of color.

Today, therefore, we have the practise of spectrophotometry and quantitative color specification in the tradition of Newton and Maxwell and, contrasted with it, the popularity of a variety of color systems based more or less on subjective classification of colors in the tradition of Goethe, Ostwald, and Munsell. The latter stop at the first statement of Aristotle, "Whatever is visible is color." The former read further and agree that "Our first task is to explain what light is."

The first nine of the fourteen chapters of Physical Aspects of Colour are concerned with the science of Newton and Maxwell: the expression of color by numbers and the calculation and measurement of colors. The reader "is assumed to be acquainted with mathematics and physics as far as they are taught in (European) secondary schools and to possess a certain amount of zeal!" The book gives the impression of being loaded with a great deal of algebra and arithmetic, which may be unavoidable considering its stated purpose. In many cases the meaning of the mathematics is made clear by skillful diagrams.

One chapter each on defective color vision, color discrimination, and the relation between measured color and color sensations round out the book. In general, it seems that "the exposition is based on established experimental facts and the prolific theories are omitted."

The physiological and psychological bases and implications of the facts of color vision are considered by Bouma

only "so far as is necessary for a better understanding of the physical aspect." In Pirenne's beautiful little book, Vision and the Eye, a few selected topics in the physiology of vision are discussed in detail. He does not deny that there are conscious sensations but simply does not deal with them.

Written with an easily flowing style, unburdened by mathematics, and illustrated with many excellent drawings, Vision and the Eye should be welcome to many "interested but nonspecialist readers." It is concerned with only part of our present knowledge of the function of the eye. Certain important properties of the visual system are explained, with adequate accounts of how existing knowledge of those properties was obtained.

The eye is considered as a complicated set of instruments for detecting radiant energy within a certain spectral range. Its sensitivity is so high that it seems to be limited only by the quantum properties of light. The fluctuation phenomena to be expected near that limit have been studied by the author among others and are well described. The maximum accuracy of the eye in the discrimination of form is high enough for the wave properties of light to play an important role. The physical principles underlying the limits of sensitivity and accuracy of optical instruments in general must, therefore, be applied to the study of the physiology of vision. The structure of the human eye and comparable structure of other creatures whose eyes are more readily available for experiment are described, to provide a foundation on which the application of physical principles can be based.

As W. S. Stiles states in his foreword, many readers will be pleased with "the very clear formulation, wherever possible in quantitative terms, of the basic notions essential to a proper understanding of the working of the eye and, secondly, the avoidance of arguments founded on introspective descriptions of sensations, which are notoriously difficult to interpret correctly."

David L. MacAdam

Eastman Kodak Company

Frontier Fragments

HIGH POLYMER PHYSICS, A SYMPOSIUM. Edited by Howard A. Robinson. Remsen Press, New York City. 1948. $12.00.

In January of 1946, during one of its first annual meetings, the high polymer division of the American Physical Society held a symposium at Columbia University in New York City. Twenty-three papers of this symposium, covering a variety of topics in the general field of high polymer physics, have now been gathered together in this volume. About two-thirds of the papers had previously been published in the research journals, but one-third have never before been published.

The topics covered include the molecular structure of high polymers, mechanical and visco-elastic properties (including such diverse materials as textile fibers, cork, rubber, and silicone fluids), thermodynamics of solutions, and instrumentation for measuring some of these properties. The papers are all written by active research specialists in the various fields, and consequently carry authority; although space does not permit listing here the large number of authors, many well known names are included.

In his introduction the editor states that much thought was given to the desirability of printing such a book, and in its support adduces two reasons: that a picture of current American research in this field should be available to those who were isolated by the war, and that any effort that will bring together the artificially separated disciplines of physics and chemistry is worthwhile. Despite these worthy aims, one still wonders. The papers in this volume are not reviews; they are all reports of current research, necessarily specialized and profusely detailed. They give an intimate picture of part of the frontier of our knowledge, but no serious effort is made to cover, even briefly, the territory behind, and even the paths which link the segments of the frontier are but incidentally mentioned. A reader would have to be already well-informed to gain a clear picture of high polymer physics from this book. For such a reader, however, it will most certainly be valuable.

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Books Received

A PROFESSIONAL GUIDE FOR JUNIOR ENGINEERS. By William E. Wickenden. 55 pp. Engineers Council for Professional Development, New York, 1949. $1.00.

THERMODYNAMIC CHARTS FOR COMBUSTION PROCESSES. By H. C. Hottel, G. C. Williams, C. N. Satterfield. Part I, Text, 75 pp. Part II, Charts, 23 pp. John Wiley and Sons, Inc., New York, 1949. Parts I and II, $2.60 each.

PARTIAL DIFFERENTIAL EQUATIONS IN PHYSICS. By Arnold Sommerfeld. Translated from the German by Ernst G. Straus. 335 pp. Academic Press, Inc., New York, 1949. $5.80.

HIGHER ALGEBRA FOR THE UNDERGRADUATE. By Marie J. Weiss. 165 pp. John Wiley and Sons, Inc., New York, 1949. $3.75.

ANNUAL REPORT, 1948, CONFERENCE ON ELECTRICAL INSULATION. 123 pp. National Research Council, Washington, D. C., 1949.

RADIOACTIVE TRACER TECHNIQUES. By George K. Schweitzer and Ira B. Whitney. 241 pp. D. Van Nostrand Company, Inc., New York, 1949. $3.25.

FIFTH SEMIANNUAL REPORT OF THE ATOMIC ENERGY COMMISSION. 213 pp. U. S. Government Printing Office, Washington, D. C., 1949.

PRE-MEDICAL PHYSICAL CHEMISTRY. By F. A. Matsen, Jack Myers, and Norman Hackerman. 344 pp. The Macmillan Company, New York, 1949. $4.75.

ELEMENTARY MATHEMATICS FROM AN ADVANCED STANDPOINT, VOLUME II. GEOMETRY. By Felix Klein. Translated from the 3rd German Edition by E. R. Hedrick and C. A. Noble. 214 pp. Dover Publications, Inc., New York, 1939. $2.95.

MATHEMATICAL FOUNDATIONS OF STATISTICAL MECHANICS. By A. I. Khinchin. Translated from the Russian by G. Gamow. First American Edition. 179 pp. Dover Publications, Inc., New York, 1949. $2.95.

MICRO-WAVES AND WAVE GUIDES. By H. M. Barlow. 122 pp. Dover Publications, Inc., New York, 1949. $1.95.

INTRODUCTION TO THE THEORY OF FOURIER'S SERIES AND INTEGRALS. Third Revised Edition. By H. S. Carslaw. Dover Publications, Inc., New York, 1930. $3.95.