

picture shown of stationary waves around Bohr orbits was really in people's minds in the early days of wave-mechanics? Or that this, in itself, is a much easier idea to understand than, say, the principle of virtual work, or even that notorious source of misunderstanding when it was first discovered, Ohm's law? In directing attention to the quite different kind of mental effort needed to master the early fundamentals, the authors have really implicitly diagnosed the fault that hinders the progress of so many students, a feeling that physics began with the twentieth century. Needless to say, the rigours of modern physics are themselves explained here very clearly.

The title might almost suggest a bias towards applied physics, but in fact only representative applications are explained at all fully. These include the circulation of the blood, thermionic valves and radio circuits, frequency modulation, three-phase power supplies, the implications of recent red-shift observations with the 200-in. reflector, and many uses of radioisotopes. The numerous brief allusions to well-known applications are relevant. Most teachers, incidentally, would treat thermometry and electrolysis rather differently nowadays.

Part 10, on the scope and importance of the physical sciences, is rather more difficult to assess. I can only say that, if I had read a book of this kind as a student, I should have realized then that philosophy is something more than the extrapolation of a classical education; and that, oddly enough, the term 'natural philosophy' means what it states. Among many issues discussed are the status of the term 'law' in the exact sciences, the fallibility of scientific method when taken beyond its proper province, and the general education of both the scientist and the non-scientist. It has been said that the way to broaden the general education of the physicist is by encouraging a thorough understanding of his subject, and its impact on people's minds and affairs. From this point of view the later chapters of the book are particularly valuable.

G. R. NOAKES

LUMINESCENCE OF BIOLOGICAL SYSTEMS

The Luminescence of Biological Systems

Edited by Frank H. Johnson. (Proceedings of the Conference on Luminescence March 28–April 2, 1954, sponsored by the Committee on Photobiology of the National Academy of Sciences—National Research Council, and supported by the National Science Foundation.) Pp. xiv + 452. (Washington, D.C.: American Association for the Advancement of Science, 1955.) 7 dollars.

THE production of light by many living organisms is a very striking characteristic and has been recognized since the earliest times. Pliny observed the glowing of rotting wood, Aristotle had an account of the light emitted by putrefying fish, and Boyle in 1667 examined the luminescence of stored meat. The early papers of Paul Panceri in 1873 on *Pyrosoma*, *Pholas* and *Phyllirhoë* are classics.

This book is an account of the proceedings of the conference on luminescence, held at Asilomar, Pacific Grove, Calif., during March 28–April 2, 1954, and the papers and the main discussion of each are given verbatim. The first paper, a survey of luminous

organisms, is by Prof. Newton Harvey, a pioneer in this field and celebrated for his classic and extensive investigations into the subject of luminescence. This is a very lucid account of the state of the existing knowledge of the problem, with stimulating suggestions for further work. Methods are described with a wealth of detail. Drs. R. S. Becker and M. Kasha follow with a discussion of luminescence spectroscopy, involving the role of chlorophyll, and the electronic state of this pigment which is concerned with the first reaction in the utilization of energy by the pigment system. The luminescence properties of porphyrin molecules are being studied by these workers, with special reference to the chlorophylls, and the singlet-triplet split in molecules is considered.

Perhaps the most interesting and informative chapter, at any rate for porphyrin workers, is that of C. Stacy French on fluorescence spectrophotometry. He describes apparatus in detail, and follows up with a most useful account of the absorption and fluorescence spectra of the chlorophylls and their derivatives, data which are not readily accessible in the literature. Wilhelmson *et al.* have a paper on chemiluminescence kinetics of the 2 : 3 dihydropthalazine 1 : 4 diones, and a mechanism for the reaction is proposed, based on the ionization, in basic solution, of the enol forms shifting the equilibrium in their favour. Oxidation of the ionized portion would then involve loss of the charge, and reaction with more oxygen would lead eventually to a molecule which, when excreted, would emit light.

Two deeply interesting chapters are those dealing with the chemistry of *Cypridina* luciferin by Drs. Tsuji, Chase and Harvey, and the biochemistry of firefly luminescence by Drs. McElroy and Hastings. The first contains much detail regarding the preparation and purification of luciferin (chromatography and electrophoresis) and a study of degradation products. The second describes purification methods for luciferin and luciferase from *Photinus pyralis*, and gives some properties of the luminescent system, including the possible role of adenosine triphosphate. The biochemistry of bacterial luminescence is very fully discussed by Dr. Strehler, with some pointers as to the mechanism involved, which seems to include the participation of reduced flavin mononucleotide. Intracellular luminescence is introduced by Dr. Frank Johnson, the editor, and includes a study of the kinetics of bacterial luminescence *in vitro*.

From the biochemical mechanisms of luminescence, the reader moves to the physiological control of luminescence, the subject of Dr. Nicol's paper, which is further discussed and extended by Dr. Buck. Dr. Nicol's main concern is with neurocontrol; there are two effector systems, muscles and photocytes, which depend on one conductor system. Oxygenation may be a limiting factor. The survey of luminous organisms of the Far East, by Dr. Haneda, is a fascinating and most useful contribution; it contains several very fine photographs. The symposium ends with two short papers, one on marine dinoflagellates by Dr. Ryther, and one by Drs. Haxo and Sweeney on bioluminescence in *Gonyaulax polyedra*.

The sequence of the contributions could be criticized; for example, the papers on control of luminescence would have been more logically placed after the papers on firefly luminescence, and the very fine survey of Haneda after the introduction by Harvey. The paper is good, the print clear and the photographs have been reproduced well. There is a good index.

G. Y. KENNEDY