BOOK REVIEWS

Toward Modern Science. Robert M. Palter, ed. Vol. 1, Studies in Ancient and Medieval Science, 270 pp.; Vol. 2, Studies in Renaissance Science, 218 pp. Noonday Press, New York, 1961. $5.00 each, $9.00 per set. *Reviewed by R. B. Lindsay, Brown University.*

THE history of science is making great strides as a professional discipline. Scientists as a whole are becoming more and more cognizant of its importance in the education of young scientists, even though some still doubt its value to the modern researcher. Professional historians are coming to realize more keenly the enormously important role that the development of science has played in history. Hence, on all sides, the appearance of new works in this field is greeted with respect.

The volumes under review constitute an anthology devoted to ancient and medieval science and contain twenty-five essays on chosen topics in this domain. The work is not, therefore, a connected account of the history of science in the period under consideration. It displays consequently both the merits and defects of an anthology. On the positive side, each article is by a recognized scholar who speaks with authority in his field. The names of O. E. Neugebauer, Sir Thomas Heath, Pierre Duhem, Charles Singer, George Sarton, etc., amply attest to the distinction of the contributions. On the negative side, the lack of coherence in the presentation provides quite a strain on the reader who wants to obtain an over-all picture. The redeeming feature on this side probably is that the reader will become so fascinated with the essays that he will be stimulated to turn to the larger works mentioned in the bibliography.

The physicist will doubtless be most attracted by the essays on medieval and Renaissance physics by Pierre Duhem, on the Arabic achievement in physics by H. J. J. Winter, on the laws of motion in medieval physics by Ernest A. Moody, and on the physics and metaphysics of Kepler's universe by Gerald Holton. But this selection is really invidious. The whole collection calls for close attention, which will be well rewarded.

The Architecture of Matter. By Stephan Toulmin and June Goodfield. 399 pp. Harper & Row, New York, 1962. $7.50. *Reviewed by D. J. Montgomery, Michigan State University.*

"BUT man . . . who cannot give a true reason for the Grasse under his feet, why it should be greene rather than red, or of any other colour . . . will (notwithstanding) examine the Art of GOD in creating the World . . . ," Sir Walter Raleigh chided the natural philosophers in his *History of the World* (1614). But husband-and-wife authors Toulmin and Goodfield in their *Architecture of Matter* (1962) tell us that man's persistence and curiosity have today extended his intellectual grasp everywhere, including certain fundamental life processes. Thus, to lift a felicitous example from Bernal, the biochemist tells us not merely why grass is green but also why blood is red, using quantum-mechanical notions to show how magnesium in chlorophyll and iron in hemoglobin (in the center of otherwise virtually identical porphyrins) give lifetimes of an excited triplet-state just long enough to let oxygen play the roles appropriate to each compound.

In their captivating book, Professor Toulmin and Doctor Goodfield attempt to give a coherent account of the whole field of theories of the structure of matter, both inanimate and animate, as these theories have evolved from the beginnings of science. The intended audience is clearly to be drawn from those who respect learning: scientists interested in the world pattern, humanists concerned with modern society and thought, or simply the educated layman. The work traces a meaningful continuity in the modes of thought about the structure of matter from Ionian times up to the present. Part I follows the threads of questions recurring from 600 B.C. to about 1700 A.D., during which period the behavior of matter, life, and mind were studied together, by the same concepts and as often as not by the same people. Then the ascendancy of dualism—the absolute division between mind and matter—growing out of the dilemmas posed by the success of deterministic mechanics, led to a splitting of the sciences. The principles of physical science developed almost completely independently of those of life science during the 18th and 19th centuries; Part II treats the development of physics and chemistry during this time, Part III the development of biology. In each case the examination is carried up to the most recent work, such as the thermonuclear furnaces of the stars and the protein factories of the cytoplasm.

To conclude the book, a brief and powerful epilog sets forth the burden of the work: A reunified view of matter and life is now forming. Matter is intrinsically neither developing nor inert; it is potentially one or the other. The chemical elements are neither organic nor inorganic; they can form gases and minerals, or viruses and cells. The distinction between living and nonliving materials is not in terms of the stuff of which they are made; the contrast is rather in terms of organization and activity. The existence of viruses, for example, shows how the absolute distinctions between the organic and the inorganic fade into differences of

degree. Yesteryear's uncrossed frontiers between the living and inert are seen to be intellectual expedients which are now outgrown. Our question remains that of the Ionians: In what common terms can we make unified sense of the whole architecture of the material world? Our answer is more satisfying, however, for the progress of the 20th-century matter-theory gives hope that a common system of fundamental concepts can embrace material systems at every level of organization.

The authors have set themselves an awesome goal, and their steps towards it are impressive. The treatment of technical material is on the whole accurate and penetrating, at least in the specialties in which the reviewer has claim to any background. In less familiar regions, I find that the treatment often strikingly elucidates matters obscured by less skillful expositors. The style is exciting and flowing, and the reader finishes a chapter with a sense of anticipation rather than relief.

Of criticisms I have two. The first is minor: The historical treatment, though literally accurate, sometimes makes for unwarranted inference—for example, the work of Rutherford and Bohr on the planetary atom is described with four references to Cambridge's Cavendish Laboratory, and with none to the University of Manchester. Yet it was at the latter that Rutherford and his pupils from 1907 through 1919 performed the alpha-scattering experiments, postulated the Bohr-Rutherford model, and first transmuted a nucleus!

The second is not so minor: A reader unfamiliar with the current biological literature would gather that the notion of a common set of concepts embracing systems at every level is universally accepted. But an important segment of responsible scientists still holds that the extensive degree of organization in living material as compared with that in nonliving material constitutes a qualitative difference between the two. Perhaps this neovitalism deserves its day in court.

This pair of talented authors, trained initially in science and then turned to the humanities, have brought an exemplary contribution to understanding and appreciation between fields of intellectual activity. Here is general education at its best.

Fifty Years of X-Ray Diffraction. Internat'l Union of Crystallography Commemoration Meeting (Munich, July 1962). P. P. Ewald, ed. 720 pp. Oosthoek Publishing Co., Utrecht, The Netherlands, 1962. $11.25. *Reviewed by Malcolm Barlow, Stanford Research Institute.*

MAX VON LAUE'S discovery of x-ray diffraction by crystals was made at the Ludwig Maximilian University of Munich, and it was in Munich, in July 1962, that scientists celebrated the fiftieth anniversary of this event. This volume, written to commemorate the occasion, looks back on von Laue's discovery, and aims to cover the development of x-ray diffraction over the past five decades.

The historical background to the discovery of x-ray diffraction is described in the initial chapters of the book. The knowledge of x rays and theories of crystal structure up to the time of von Laue's discovery are clearly stated, and Professor Ewald vividly relates how von Laue first conceived, and then experimentally verified the idea that crystals irradiated with x rays might give rise to interference phenomena. The work of W. H. Bragg and W. L. Bragg, and their development of crystal-structure analysis is then described, and this leads to a new chapter dealing with the principles of x-ray diffraction. The presentation of material up to this point is excellent, but unfortunately this standard is not maintained throughout the book.

In the next seventeen pages the various problems and methods of crystal-structure analysis are reviewed; however, some important aspects are not covered adequately. For example, the problem of phase determination is dealt with only briefly, and little mention is made, either here or elsewhere, of new methods such as direct, image-seeking, and superposition techniques.

Well-known workers in the field of x-ray diffraction then review topics such as the growing power of x-ray analysis, organic and inorganic structures, the impact of x-ray diffraction on physics, and x-ray spectroscopy. A short account of the dynamical theory of x-ray diffraction, extended to cover electron and neutron diffraction, completes the first part of the book.

The next part of the book consists of a fine collection of biographical essays of famous crystallographers. These are written informally, and the biographies of Max von Laue, W. H. Bragg, Charles Mauguin, and

Max von Laue