REVIEW OF PUBLICATIONS

Men of Physics—Sir Arthur Eddington by C. W. Kilmister. Pages v + 279; $5\frac{1}{8} \times 7\frac{3}{4}$ in. (paperback). Toronto, Pergamon of Canada Ltd., 1966. Price $5.95.

This book, by the Professor of Mathematics at Kings College, London, is one of a series entitled Selected Readings in Physics—Men of Physics, and forms part of the Commonwealth and International Library of Science Technology Engineering and Liberal Studies.

Professor Kilmister has for many years been fascinated by the pioneering insight of Eddington into a wide range of physical problems involving astrophysics, quantum theory and relativity, recognizing in him an unorthodox genius the movements of whose mind are often so provocative as to justify a detailed study. The author brings to this task a widely trained mathematical mind and a comprehensive knowlege of developments in quantum theory, relativity physics and particle physics prior and subsequent to 1944, the date of Eddington's death. He brings also the historical perspective which enables him to study Eddington's work within the context of the total physical and theoretical knowledge available in Eddington's day. As he says "An account of Eddington's work is bound to be an account of theoretical physics in the first half of the twentieth century".

With rapier-like incisiveness he follows in detail Eddington's mathematical and verbal arguments pointing out the consequences of self-imposed limitations, dubious deductions, erroneous choices where a pioneer with the limited view of his day must choose between one untried path or another.

Part I of this book (pp. 1–79) is mainly its author's discussion of astrophysics, quantum mechanics, relativity theory, algebraic structures; the gulf between relativity theory and quantum theory, and the Eddington statistical theory. It is a masterly review which sets the stage for Part II (pp. 97–276). The most complete bibliography to date is given on pp. 80–93.

Part II consists of selections from Eddington's books and papers under eleven headings. From *The Internal Constitution of the Stars* (1926) the selections deal with Solution of the Equations, The Gas Laws in Dense Stars, White Dwarfs, The Source of Stellar Energy. From *Phil. Mag.*

(1925) is taken the Derivation of Planck's Law from Einstein's Equation. From *Mathematical Theory of Relativity* (1923) several sections on Generalized Theroy are quoted, and Eddington's "Conclusions" which Kilmister remarks "summarize very strikingly the unorthodox views of the role of theorizing in physics which [Eddington] already held in 1923".

From *Journal London Math. Soc.* (1933) comes the Factorization of E-numbers with perceptive comments by Kilmister on Eddington's mistaken attribution of "great importance to the occurrence of idempotent quantities in the algebra" and on his concentration of interest in "the general shape of things—and in particular the numbers which arose from the detailed algebraic structure". From *Proc. Roy. Soc.* (1935) is taken The Pressure of a Degenerate Electron Gas and Related Problems in which Eddington related wave functions with curvature. "Until we understand, for example, what corresponds to the curvature tensor when we go over to the quantum mechanical picture we cannot make the comparison which we want to do. The understanding of this led Eddington to his characteristic generalization of the Dirac algebra, in the exploitation of which he was alone."

A short extract follows on the Riemann-Christoffel Tensor from *Relativity Theory of Protons and Electrons* (1936). Followed by an important manuscript on The Transfer Problem which came to light after the publication in 1957 of Professor N. B. Slater's book on the several drafts of *Fundamental Theory* (posthumous 1946). Kilmister's notes on this are illuminating, stressing Eddington's insistence on two facts: the role of the observer in physics and the impossibility of removing him completely, and the mathematical fact of the existence of an underlying non-linearity in physical theories. This led Eddington to attempt to combine two restrictions, the observability of only relative velocities and the uncertainty principle in quantum mechanics.

The final selection is on Mutual and Self Energy from *Fundamental Theory*. Eddington's famous quadratic for the proton-electron mass-ratio is discussed by Kilmister in one of the most interesting sections of this book (pp. 269–271). He concludes "The value of his later work lies much more in the suggestions it throws up than in its actual achievements."

One of the greatest tributes that could be paid to Eddington is that nearly a quarter century after his death a man of Professor Kilmister's stature should undertake to write such a book as this.

A photograph of Eddington by Coster adorns the cover of this paperback and the frontispiece is from a chalk drawing by Augustus John in Trinity College, Cambridge.

A. VIBERT DOUGLAS

Explorer of the Universe, by Helen Wright. Pages 480; $5\frac{3}{8} \times 8\frac{1}{4}$ in. E. P. Dutton & Co., Inc., New York, 1966. Price $12.50.

"Explorer of the Universe" refers to George Ellery Hale, 1868-1938, and is the title of a biography. During his life, Hale was able to organize the pioneering development in a series of great telescopes, each one an achievement in itself. The culmination was the 200-inch (508 cm) telescope for Mt. Palomar which was named in his honour during the official opening in 1948. Even today, 39 years after the original proposal, this instrument still ranks as the largest in the world. His first step in exploring the universe occurred at the age of 14 when he was able to pursuade his father to purchase a 4-inch Alvin Clark reflector. Three years later, he obtained a 1-inch grating from Brashear in order to study the dark absorption lines in the solar spectrum. He studied physics at M.I.T. and it was there that the life-long friendship with the chemist Harry Goodwin was commenced. The correspondence between the two friends has been carefully preserved and provides the basis for this biography. After marriage to Evilina Conklin at the age of 22, the Hales journeyed west to visit the Lick Observatory which had the largest telescope at that time. The many possibilities for his future, including his formal studies for a Ph.D., were set aside when his father provided a 12-inch telescope for spectroscopic experiments to analyse the light from the sun and stars. Hale was a proponent of the then "new" astronomy which advocated the application of the methods of physicists for the solution of astronomical problems. In 1895, this resulted in Hale assuming the editorship of the newly founded *Astrophysical Journal*. In due time the Kenwood Observatory in the back yard of the family residence was succeeded by the Yerkes and Mt. Wilson Observatories, the Solar Laboratory and the Mt. Palomar Observatory. The resulting flood of observations has provided and is still providing much of the background data upon which present day theories of the evolution of the universe must be built. Not so widely known, but of equal importance, are his contributions to the establishment of the National Research Council of the U.S.A. in 1916, the California Institute of Technology and the International Union for Co-operation in Solar Research: later the I.A.U. He was personally devoted to problems related to the sun, developed the spectrohelioscope for obtaining pictures of the sun in the light of various elements and established the presence of magnetic fields in sun-spots.

Unfortunately, such achievements were not always free from difficulties and in later life were accompanied by personal stress. This contributed to his poor health which led in 1922 to his resignation of the directorship of

the Mt. Wilson Observatory. In the ensuing period of restricted activity, he became an amateur astronomer once more with the construction of his "Solar Laboratory" in Pasadena. Strangely enough, the office and library of this small observatory soon witnessed the unfolding plans for the 200-inch telescope. Hale was a scientist engineer with a deep interest in the humanities. He shared a common interest in books with Huntington and became involved in the establishment of the Huntington Library and Art Gallery. Another visible expression of this concern was the use of Egyptian designs in the decorations of the Solar Laboratory.

The biography was written at the request of Walter Adams, who assumed the directorship of Mt. Wilson Observatory from Hale. The writer has sought and has received assistance from members of Hale's family, colleagues and friends. She has decided that the activities of such a rich life could not be presented in chronological order and consequently has skillfully used a number of separate accounts built around his various interests. Numerous references to primary sources have been conveniently collected in 30 pages at the back of the book. Many of the technical aspects of astronomy have been briefly explained so that the book should appeal to a wide range of readers. This important biography is well written and is highly recommended.

A. E. COVINGTON

The Solar Wind, edited by R. J. Mackin, Jr. and M. Neugebauer. Pages xxx + 419; 6 × 9 in. Pergamon Press, 1966. Price $17.00.

In April of 1964 the Jet Propulsion Laboratory, California Institute of Technology, held a conference at which the then-new findings of the Mariner 2 and Imp 1 space probes were presented and discussed, along with other observational and theoretical material on the solar wind. The proceedings of that conference—some 26 separate papers along with the discussions that followed each presentation—are contained in this volume. Of the five main parts of the book, essentially only the first—on Phenomena Observed in Interplanetary Space—contains the new results that formed the *raison d'être* for the conference. The other four deal with the general topics of Theories of the Interplanetary Plasma and Fields and of Energetic Particles, Origin of the Solar Wind and the Corona, The Solar Wind and the Magnetosphere, and Solar Wind Interactions with Comets and with the Moon. Some of the chapters are in the nature of review papers, while others are papers that were generated spontaneously at the meeting. Along with other conference proceedings this book suffers from subject fragmentation, but to a significantly lesser extent than most.

Because participation was restricted to leading researchers in the field, this volume represents a summary of the research situation on the solar wind at that time, along with much valuable background material and theoretical arguments. The uninhibited discussion—which provides a much-needed measure of integration between isolated papers—has been preserved and in it one finds a growing promise of a consensus of opinion on this complex subject. It is most regrettable that the publication process was such a lengthy one in this case as some of the material is already out of date. In spite of this, its wide scope should make it a valuable reference book for some considerable time to come.

T. R. HARTZ.

Canon of Solar Eclipses by Jean Meeus, Carl C. Grosjean, and Willy Vanderleen. Pages vii + 749; $8\frac{1}{2} \times 11$ in. New York, Pergamon Press, Inc., 1966. Price $35.20.

Astronomers and historians alike have benefited from the "Canon der Finsternisse" by T. R. von Oppolzer, first published in 1887. This monumental work tabulated data for 8,000 solar and 5,200 lunar eclipses during the period 1200 B.C. to A.D. 2200. Besides making important contributions to the study of the dynamics of the Earth-Moon system, the Canon has also found application in historical research for dating purposes. Some limitations of the theory on which the tables were based were recognized during their preparation and others have come to light more recently. Adequate precision cannot be achieved for many prediction purposes by using the material from the Canon alone.

The new "Canon of Solar Eclipses" has taken advantage not only of improved orbital theory and data but of the speed and accuracy of modern electronic computers. It extends the tabular data for another 1450 solar eclipses from A.D. 1898 to A.D. 2510, continuing the serial notation established by Oppolzer to No. 8850. Besides greater accuracy, the new work presents far more detailed data on each eclipse. Part I tabulates briefly the basic general data characterizing each eclipse. Part II presents the Besselian elements at hourly intervals for the duration of each eclipse. Part III gives data for the central lines not only at the mid and end points but at 12-minute intervals for all but a very few eclipses. Part IV consists of charts of central lines plotted from the material in Part III. The tables are preceded by an introduction of 40 pages containing a complete description of all tables, a discussion of basic theory and computational details, numerical examples to illustrate the practical use of the tables, and a comparison of the new tables with both Oppolzer's work and the Astronomical Ephemeris.

The tabular material has been conveniently and clearly arranged in a volume of high quality. To eliminate printing errors, Parts II and III have been reproduced by photo-offset printing directly from the output sheets of the IBM data processing system. The Belgian authors have clearly been motivated by the same high standards of excellence set by Oppolzer to justify the title "Canon" for their work.

V. GAIZAUSKAS

The Nature of the Lunar Surface, ed. by W. N. Hess, D. H. Menzel and J. A. O'Keefe. Pages viii + 320; 8 × 10 1/4 in. Johns Hopkins Press, Baltimore; Copp Clark Publishing Co. Price $13.50.

In 1965, Commission 17 (The Moon) of the IAU, and NASA jointly sponsored a symposium on the nature of the Moon's surface. Eminent astronomers, astrophysicists, astrogeologists, and terrestrial geologists presented their views and experimental results on topics ranging from the age-old question of the origin of the Moon itself, through the morphology and origin of lunar craters large and small, to the nature of the 1mm-size particles blanketing the maria floors. The entire oral proceedings are presented in this volume, edited to eliminate the pauses, repetitions, and "next slide please" requests, but retained are the valuable comments, questions, and discussion directed to the speakers at the close of each paper.

Ranger VII, VIII, and IX photographs are analyzed by Shoemaker, Urey, Kuiper, and others, and from them the reader soon is able to recognize primary craters, secondary craters, dimple craters, bright- and dark-halo craters, rilles, wrinkles, scarps, terraces, and other surface forms. These full-page Ranger photographs are the highlight of the book filling almost one third of its pages.

Included in Part II are the results of terrestrial experiments attempting to duplicate lunar crater formation, plus articles dealing with optical and thermal properties of the Moon. Part III includes studies on additional physical data such as "hot spots", radar observations, and radio measurements of the lunar surface. The characteristics and forms of terrestrial calderas and pyroclastic deposits are compared with some of the lunar craters and their surrounding lithic material.

Ernst Öpik sums up the conference, and compares and contrasts the ideas presented, to which he adds his own views. A lengthy panel discussion is also presented in whole with the moderator feigning ignorance in order to ask the more elementary questions, thus keeping the discussion at an understandable level.

The only criticism offered is that it is not always easy to pinpoint on the Ranger photographs the feature that the speaker is describing. During the oral presentation it was a simple matter to point to the crater in question on the projection screen, but in transposing the oral to the written the reader is often left to himself to find these features on the photographs.

This is a book for both the astronomer and the geologist; for the amateur and the professional alike. In the light of the more recent information gained from the voyages of the Luniks, Orbiters, and Surveyor, it is interesting to note that these earlier views and theories are reasonably accurate in their description of the true nature of the lunar surface.

P. B. ROBERTSON