REVIEW OF PUBLICATIONS

Astronomy Transformed: the Emergence of Radio Astronomy in Britain by David O. Edge and Michael J. Mulkay. Pages 482; 23.5 × 15.5 cm. John Wiley and Sons, New York and Toronto, 1976. Price $26.50.

This book, one of the Wiley Interscience Series, describes the early development of radio astronomy in Britain, and to some extent in Australia. The authors document the post-war emergence of radio astronomy as it evolved from meteor and solar observations and focus on the development of the two major British radio-astronomy centres – Jodrell Bank and Cambridge. Their story ends in 1962. Much of the book is based on detailed interviews with radio astronomers who worked in these two groups prior to 1962. Those interested in an inside account of developments, rivalries and motivations within the radio-astronomy community during this period will enjoy the anecdotal recounting of life at Jodrell Bank and Cambridge. There is a wealth of notes and references scattered throughout the book and in three appendices. On this account it provides a useful chronology and reference source for future historians of science, as well as for anyone interested in the history of this important branch of astronomical research.

Up to now I have mentioned only one aspect of this book. The main aim of the authors is not merely to describe the history, but rather to use the historical material and their many interviews as a case study to analyse the development of a new scientific discipline. Their story is interspersed with lengthy comments on this theme, and attempts to generalise and to establish basic principles which are supposed to explain how a novel area of scientific endeavour arises, breaks loose from the established scientific community, gradually becomes "acceptable" and in the course of all of this, how the general scene of research is permanently changed.

Much of this discussion in uninteresting and boring. It expands the book to a size which is out of proportion to their ability to draw significant conclusions. They conclude their study with feeble and largely unsuccessful attempts to discern general principles for elucidating patterns in the development of science. At the end of the book there is some comparison of the findings of this study with the ideas and conclusions of T. Kuhn, W. Hagstrom, J. Ben-David and others, on the history and evolution of scientific thought. By their own admission (in Chapter 10), their study is too limited to add new insight to what has already been said by Kuhn and

Hagstrom, although they find points of corroboration with some conclusions by these other historians of science.

While it contains interesting and, in part, readable source material, this study is limited and suffers from a certain parochialism by restricting itself to the British radio-astronomy scene. In doing so, it has neglected some important developments in the U.S.A. (in particular the birth of radio spectral-line observations other than those of neutral hydrogen), in the U.S.S.R. (where important and far-reaching new ideas in related theory were generated), the Netherlands and Canada.

Few will be motivated to buy this book, but it will contribute to the historical anthology of modern astronomy.

PHILIPP P. KRONBERG

Beyond the Moon by Paolo Maffei, translated by D. J. K. O'Connell (original 1973 Italian title was *Al Di Là Della Luna*). Pages 377; 6 × 9¼ in. M.I.T. Press, Cambridge, Mass., 1978. Price $15.00.

Beyond the Moon is a popular work of astronomy intended, I must say, for the scientifically inclined public. I believe the author gives too many technical details to appeal to the general public. Maffei explains in the preface that he had the idea of writing this book after the *Apollo 11* lunar landing, wishing to correct the general impression that after the conquest of the moon, the rest of the Universe would follow soon. The book describes the Universe in order to show that the step to the moon was microscopic on the cosmic scale.

The author takes us on an imaginary journey, starting on the moon and ending at the edge of the Universe. Scenes are vividly described at imaginary stopovers along the way, for example, the view of the double star Alpha Centauri from a planet, or the appearance of the sky as seen from the centre of M 13. These descriptions could certainly inspire science-fiction writers. On his way to the quasars, Maffei describes the current astronomical knowledge about the solar system, the Galaxy and the Universe. Nearly everything that is known about the solar system, for example, is there. We learn that in 1937 the asteroid Hermes came within 800,000 km from the earth, and Maffei mentions the near-miss over Alberta in 1972. Mention is even made of the rings of Uranus. The stellar sections are also filled with details and facts which certainly cannot be absorbed by the casual reader. I am thinking of such data as the frequency of the radio lines of OH or the orientation, the length and the width of the jet in the galaxy M 87. There are,

however, many historical facts of interest scattered throughout the book. I learned for instance that Halley discovered the globular cluster M 13.

It is always a challenge to write a popular book in astronomy; should we talk of a million billion or use exponents? The first exponent in *Beyond the Moon* appears on page 119, and they are used thereafter. Kepler's third law is used, as well as trigonometric functions. The determination of distances is explained in one of the appendices. Light years are used throughout, but parsecs do appear on three occasions. I noted some ambiguities concerning temperatures; after temperatures have been given in °K and °C, the temperature of the core of the sun (p. 21) is quoted as 25 million degrees, which must be in Fahrenheit.

An attentive reader could notice that the original book was written five years ago; picture credits (which are very numerous) are given to "Mount Wilson and Palomar Observatories" which are now called the Hale Observatories. The 200-inch telescope is repeatedly classified as the largest in the world.

Beyond the Moon cannot be considered an elementary book, mostly because of the large number of concepts assumed to be known. I am sure the serious amateur, astronomy students and astronomers in general would enjoy this book. I particularly recommend it as "supplementary reading" to students preparing for a Ph.D. oral examination. This book will give them the opportunity to review the astronomical universe, minus the moon, and it is more interesting to read than a textbook.

SERGE DEMERS

Cosmic Dust edited by J. A. M. McDonnell. Foreword by Hannes Alfvén. Pages 693; 6 × 9 in. John Wiley and Sons, Inc., New York, 1978. Price $67.00 (cloth).

Cosmic Dust is a compilation of review articles on nine topics related to the study of small particles in space. The intent of this publication is to provide for the first time in one volume a comprehensive review of these different areas of research and to present the material in a manner suitable for study by graduating and postgraduate university students in the physical sciences. The chapters (and their respective authors) are entitled: Comets (F. L. Whipple), Zodiacal Light as an Indicator of Interplanetary Dust (J. L. Weinberg and J. G. Sparrow), Meteors (D. W. Hughes), Interstellar Dust (J. M. Greenberg), Microparticle Studies by Sampling Techniques (D. E. Brownlee), Microparticle Studies by Space Instrumen-

tation (J. A. M. McDonnell), Lunar and Planetary Impact Erosion (D. G. Ashworth), Particle Dynamics (J. S. Dohnanyi), and Laboratory Simulation (H. Fechtig, E. Grün and J. Kissel).

Each chapter presents a brief historical introduction to the topic followed by a more detailed critical discussion of current research in the field. The style is similar to that used in the *Annual Review of Astronomy and Astrophysics* and in the *Stars and Stellar Systems* series, with numerous figures and photographs included in the text. In contrast, however, the reference lists at the end of each chapter are longer and more detailed than those in comparable publications. This is a definite asset to the text since it provides interested readers with complete information on additional reference material.

The text is definitely directed to the specialist since each author includes in his discussion a concise development of the physical arguments necessary for a full understanding of research in his field. These sections can be tedious for the non-specialist, but are easily ignored for those interested only in the useful, up-to-date information presented on each topic. There is considerable attention paid to recent developments in the study of small cosmic particles using space vehicles, an area which appears to be gaining in interest among scientists these days. There is much in the text to give one a better appreciation of current progress in this area.

I cannot help but feel, however, that the title of this publication is deceiving. The one chapter devoted to a discussion of interstellar dust gives only a partial (and sometimes misleading) glimpse of recent progress in this area, and the remaining eight chapters are all devoted to topics related to the study of dust in the solar system. Reading through the text I found a disproportionate amount of material on the topic of microparticle sampling, at the expense of whole topics related to the study of interstellar dust. This in undoubtedly a consequence of editorial bias. Nevertheless, because of this feature I cannot recommend *Cosmic Dust* as a comprehensive review of all areas involved in the study of small particles in space, although it may provide a good in-depth review of those areas related to the study of interplanetary dust. In my opinion this publication is more suited to specialists in space science than to astronomers, but the material should be of interest to both.

The text contains only the usual number of typographical errors for a first printing (interestingly, these are more numerous in the editor's own chapter than elsewhere), and these do not detract from its readability. The price seems somewhat high compared to similar publications, however, and this will probably influence instructors who are interested in it as a possible course textbook. Since it does provide interesting, up-to-date reviews of a

number of areas pertaining to the study of cosmic dust, it would clearly make an ideal addition to any reference library.

DAVID G. TURNER

The Theory of Relativity Revisited by H. W. Grayson. Pages 261; 6 × 9 in. Dorrance and Company, Inc., Ardmore, Pennsylvania, 1978. Price $10.00.

After a complete reading of this book it is with regret that I have to report the following: in my opinion that which is new is wrong, and that which is not new is either discussed incorrectly or in an uninformed manner.

KAYLL LAKE

Comets, Asteroids, Meteorites – Interrelations, Evolution and Origins edited by A. H. Delsemme. Pages xxi + 587; 15 × 23 cm. The University of Toledo, 1977. Price $36.50.

This fine volume is based on the material presented at IAU Colloquium 39, held in Lyon in August, 1976, just before the Grenoble General Assembly of the Union. It is not a normal volume of conference proceedings, however, for it includes a few papers not presented in Lyon; all papers have been refereed, many have been updated and only two-thirds of those submitted have been retained in the volume. When Professor Delsemme began organizing the colloquium he stressed that the emphasis was to be on the interrelations among the small members of the solar system and this emphasis has been retained in the selection of papers published.

The 74 papers are divided into nine groups with five pages of conclusions by the editor at the end. The groups, with the number of papers in each, are: physical nature of comets (10); the orbital evolution of comets (6); meteors and meteoroids (8); physical nature of asteroids (8); orbital evolution and fragmentation of asteroids (10); primitive meteorites (9); differentiated meteorites (5); the origin of comets (7); and the primitive solar nebula (11). Inclusion of much of the discussion after each paper adds to the value of the book by indicating areas of disagreement or the direction in which future work should proceed.

Among the papers of particular interest are Whipple's paper on the constitution of cometary nuclei with discussion of the importance of cosmic-ray bombardment of comets; papers by Marsden and Kresak on the Oort cloud of comets; a whole group of papers on asteroid sizes, albedos

and surface properties; Delsemme's paper on the origin of comets and R. N. Clayton's evidence of isotopic anomalies in the solar system which suggest rather incomplete mixing within the solar nebula. Readers will tend to agree with A. Brecher that "recent progress has been rapid, but a coherent view of meteorites, their origin and evolution has yet to emerge". The statement might well be applied to almost all areas covered in the book.

Publication costs of the volume were controlled by photographing typescript instead of typesetting and the finished product is quite acceptable. Some confusion crept in on pages 112–115 where page 113 should precede page 112 and a line or so on page 115 may be missing. The editor is to be commended, not only for his tireless efforts in organizing the colloquium itself, but for producing this volume which should help to unify several diverse areas of solar-system research.

IAN HALLIDAY

Physical Processes in the Interstellar Medium by Lyman Spitzer, Jr. Pages 318; 16 × 24 cm. John Wiley and Sons, New York, 1978. Price $15.95.

This is a very aptly titled book. It is principally concerned with the physics governing the thermal and dynamical states of the gas and dust of the interstellar medium, both in the various types of clouds found scattered through the disk of the galaxy, and in the relatively hot intercloud medium. More briefly, the book touches on the interaction of the dust and gas with the cosmic rays, X-rays and magnetic fields which also permeate interstellar space, and reviews processes involved in the formation and evolution of molecules and dust grains.

The book is divided into three general sections. The first considers the physical mechanisms governing thermal equilibrium for the gas. Radiative and collisional processes are discussed extensively, and the resulting types of equilibria achieved in various circumstances are surveyed. A second section considers the absorption properties, alignment mechanism and thermal equilibrium of the dust grains. Finally, the third section surveys various dynamical situations encountered in the interstellar medium—the dynamical equilibrium of the galactic disk and of clouds within it, the dynamical effects of HII regions and supernova explosions, and gravitational condensation and star formation.

The present book is a completely rewritten and updated version of Spitzer's *Diffuse Matter in Space*, published in 1968. The new book contains almost twice as much textual material as the original, and of course includes many new results. The organization of the material on physical

processes in the gas has been greatly changed in rewriting, but the basic organization of the sections on dust and on the dynamics of the interstellar medium is similar to the organization adopted in *Diffuse Matter in Space*.

The format of *Physical Processes in the Interstellar Medium* is essentially to discuss groups of more-or-less tractable problems in theoretical astrophysics which deal with the interstellar medium. This organization has the advantage of making the techniques involved in solving the problems, and the limitations of the resulting solutions, quite clear. On the other hand, the organization does not particularly assist the reader to extract a clear general picture of the interstellar medium from the book, a difficulty which is only partly rectified by an introductory chapter intended to provide such a general picture.

To use the book effectively, the reader must have a good background in both physics and astronomy, equivalent to an honours B.Sc. at least. The book is very compactly written, so that some previous acquaintance with the astronomical situations discussed and the physics used is extremely helpful. This is not a textbook that would be suitable for an undergraduate course, although it should be quite accessible to a reasonably well-prepared graduate student.

The book should also be very useful as a reference book because of the care with which Spitzer explores each problem discussed. Usually the examination of a problem begins with a general qualitative reconnaisance of the fundamental physics involved. Limitations of and approximations used in solutions for various cases are spelled out clearly. This is in refreshing contrast to at least one other recent graduate astronomy textbook in which results are neatly laid out without any discussion at all of their limits of validity. Spitzer's care in examining the limitations of the results he presents should be of considerable value to anyone wanting to apply material from the book to new areas.

One serious shortcoming of *Physical Processes in the Interstellar Medium* as both a textbook and a reference book for someone not a specialist in this area of research is the lack of problems at the ends of the chapters. It is common to omit problems from astronomy books at this level, but it is in my opinion a *most* unfortunate omission. Simply reading a book through gives one relatively little useful mastery of the material; this usually comes only from application of the new techniques to problems that the reader solves for himself. It is a real help to the reader for the author of such a book to supply a reasonable number of problems. This is especially true for students, who are often not yet skilled at inventing small self-testing problems for themselves. The importance of problems is well known to writers of physics textbooks, but does not seem to have been

discovered by many astronomers yet. The inclusion of ample problem sets is also a great aid to the teacher who must teach a course outside his own general area of research, a rather common situation for astronomy teachers.

I think that *Physical Processes in the Interstellar Medium* is a very good book, within the limitations that I have discussed above. It is definitely a book to be bought by science reference libraries which maintain any serious advanced collection of astronomical monographs. The book should also be quite valuable to astronomers working on research which touches on the interstellar medium. As a graduate level textbook it should serve very well, provided that the instructor expects to offer additional material to help the students see the forest as well as the trees, and provided also that it is supplemented with a good problem set. On the other hand, it is not a book for even the serious amateur astronomer, and probably not a book for the professional from another field who simply wants a general overview of our current picture of the interstellar medium.

J. D. LANDSTREET

The Cambridge Encyclopaedia of Astronomy edited by S. Mitton (editor-in-chief), written by fifteen contributing authors, mostly from the University of Cambridge. Pages 496; 26 × 25 cm. Prentice-Hall of Canada Ltd., Scarborough, Ontario, 1977. Price $35.00.

In the strict sense of the word, this encyclopaedia is not an encyclopaedia. Although it gives information on all branches of one subject, the material is not arranged in ABC order, except for the 13½-page comprehensive subject index. Nonetheless, it is an impressive book of reference and general reading with the most emphasis on the very latest discoveries, but by no means does it neglect classical astronomy.

The topics are arranged in thematic order. The book opens with a general survey of the Universe and continues with a description of the stars, the solar system, the interstellar medium, galaxies and cosmology (perhaps the most difficult chapter for the layman despite the well-written fascinating account). Chapters are also included on life in the Universe, highlights from the history of astronomy and instruments and techniques. In principle, the reader could open the book at virtually any chapter although a continuous reading from page 1 through 476 is to be recommended. Although basically non-mathematical, symbols and physical units are unavoidable for the sake of conciseness. These are explained in a section on "Abbreviations". (The precision strived for here is somewhat marred by the inadvertent reversal

of the symbols for galactic longitude and latitude.) Two appendices are presented: one is a star atlas which I consider to be a dull, computerized substitute for the charts in *Norton's Star Atlas* (on whose format it appears to be based anyway, but without star names, etc.) and an excellent "Outline of Physics" which eloquently embraces (in nine small-print pages of words only) practically all the basics of modern physics (which forms the theoretical basis of all astronomy). The "Outline" is suitable to anyone possessing even an elementary background in physics. In this respect, probably the most positive point of the whole book is its intuitive way of making often difficult astrophysical processes plausibly easy to understand. This is unfortunately not always the case, however, and in particular I would like to have seen more or at least *some* explanation for a number of phenomena. For example, it is curious that the mass of a black hole should *decrease* after capturing one of the particles produced in matter-antimatter creation. Furthermore, I am sure many readers will ask themselves "what is the physical explanation of the equation of time?, how do we know that Saturn's rings are 2–3 km thick?, or why do the central parts of galaxies contract more rapidly than do the outskirts?".

Among the text is dispersed a very generous number of photographs and figures of generally excellent quality. However in a reference work such as this, I was disappointed by the frequent lack of precision and essential details (e.g. in the labeling of axes) of the figures, not to mention their often (unavoidably?) awkward placement relative to the text. From my list of 24 figures with such deficiencies, a few of the most serious are as follows: I could not find Sirius B with any certainty in any of the (time?) sequence of photographs in figure 5.4 nor could I locate with certainty the "very small bright circle" representing the Arizona meteor crater in figure 12.11 (perhaps other readers will have a keener eye). The colour green seems to have been a source of trouble: besides green photos of our moon, there is some defect regarding the green dots in each of figures 3.2, 15.4, 16.15 and 17.4. More serious is the placement of the earth's orbit among the asteroids in figure 12.7 (a possible overreaction, to decentralize a step further the importance of the earth in the Universe?).

The credibility of the encyclopaedia is somewhat further tarnished by numerous errors and inconsistencies. While I counted without effort 19 errors of an editorial nature (e.g. UBVY in lieu of uvby on p. 28; the composition of the sun in table 8.1: 75% H, 25% He, 1.6% rest = 101.6%; wavelength 1 mm instead of 1 μm for the near-infrared on p. 417; NGC 2532 should be 3532 on the star chart centred at $\alpha = 12^h$). A dozen, more serious defects exist, among which are: on p. 261 the non-setting sun is referred to as white in colour while, earlier in the book, white was reserved for A stars,

yellow for the sun. Of the matter in the galactic centre (p. 306), half the mass is claimed to be in the form of neutral hydrogen, half in molecular hydrogen and 1% in dust: where does the ubiquitous primordial helium enter? The modelling of galactic rotation curves to determine the mass distribution is described on p. 310 such that "outside this [circular] orbit, the attractive forces on the moving body all cancel each other exactly, because of the symmetrical distribution of the matter": this is only true in some special cases, e.g. for an oblate spheroid, but not e.g. for a flat disk of uniform thickness. On p. 317, the radius of M 31 is given as 25 kpc while in table 15.3 the same galaxy has a linear *diameter* of 16 kpc. On p. 377 one refers to "electrons moving *at* the speed of light": this violates one of the principles of relativity pointed out in the appendix. The period of rotation of the plane of the Foucault Pendulum is not the same everywhere on the earth as implied by the text on p. 387.

Generally, the literary style is (for better or for worse!) not exactly that of Oxford scholars. Stars are "scattered all over the place" and "fluffy". Other unusual expressions are "twistiness", "one may try an attempt to find ..." or galaxies that "gobble each other up". But the occasional dab of humour agrees well with the relaxed style: e.g. concerning the names of asteroids like 694 Ekard = Drake spelled backwards, or "Sgr B2 contains enough ethyl alcohol to make 10^{28} bottles of whisky".

Perhaps owing to the present (non-lasting?) lull in space travel, M. Ryle in the "Foreword" and S. Mitton in the "Introduction" call the encyclopaedia "a reference work of lasting value". At the same time they acknowledge the rapidity with which astronomy is developing. Although I would class it near if not at the top of the list of existing works of its kind, it will, like any reference book, inevitably become outdated as the mystery of the QSO's or the PSR's (see "Abbreviations") becomes unravelled during the imminent intense era of space telescopes. Perhaps the authors' own limitation in this respect is adequately reflected in the final date of the table of eclipses: November 1985 (just one year after 1984 ...).

ANTHONY F. J. MOFFAT

The Small Magellanic Cloud by Paul W. Hodge and Frances W. Wright. Pages 80 + 202 photographic charts; 30 × 30 cm (box). University of Washington Press, Seattle, 1977. Price $50.00 (US).

Galaxies and Clusters of Galaxies in the Direction of the SMC by Paul W. Hodge (Supplement No. 1 to the above). Pages 12 + 60 overlays; 36 × 28 cm. Department of Astronomy, University of Washington, Seattle, 1977. Price $15.00 (US).

No library of any institution at which astronomical research or advanced teaching is performed should be without this splendid companion volume to the classic Hodge and Wright atlas of *The Large Magellanic Cloud*, published a decade ago. The influence these atlases will have on astronomical research in our nearest neighbouring galaxies is as vast as the importance of the objects they chart so beautifully and carefully.

It is difficult to convey the wonder aroused in a northern-hemisphere astronomer when first sighting the "Cape Clouds" of early European seafarers. Indeed, after a lifetime of catching glimpses (when one happens to be under a very dark, clear sky) of the faintly discernible fuzzy patch that is M 31, the Andromeda Nebula, the sight of *two entire galaxies* splayed out before one's eyes is truly breathtaking. This spectacular astronomical show arises, of course, from the proximity of these irregular galaxies to our own galaxy. Their nearness signifies that with a modest 0.8-m telescope stars of the same intrinsic visual magnitude can be observed in the Magellanic Clouds, as the Cape Clouds are known today, as with the 5-m Hale telescope in M 31, the nearest galaxy accessible to northern astronomers.

The possibility of being able to intercompare objects of differing luminosities at the same distance, while also being able to examine intrinsically faint members of galaxies in which star formation has evidently taken a vastly different course from that in our own galaxy, has permanently changed the course of modern optical astronomy. In the late 1950's a growing awareness of the urgent need for greatly expanded optical facilities in the southern hemisphere led to the creation of such observatories as Cerro Tololo, La Silla and Las Campanas in Chile and the Anglo-Australian Observatory in Australia, thereby giving U.S., European and Australian astronomers guaranteed access to large telescopes in the south. The effectiveness of those telescopes is highly dependent upon the quality of the maps available to guide their users, and the work of Hodge and Wright superbly fills one of the most important of the numerous gaps in our knowledge of the face of the rich southern skies.

Detailed investigation of the brighter members of the Magellanic Clouds began in earnest at Harvard during the early part of this century and relied upon early expeditions to the southern hemisphere for plate material. Unfortunately early publication budgets prevented much of the accumulated material from being adequately published, and Hodge and Wright realized some 20 years ago that much of it was in danger of being lost.

In the two atlases they arrest the ravages of time upon the yellowing and crumbling record sheets of Shapley and his co-workers, whose study of SMC (and LMC) variables extended over decades. As Hodge and Wright explain: "The chief problem encountered by each past worker on variable stars of the SMC is the abundance of variables. Especially with only the *X*

and *Y* position (very approximate) the worker may often think that he has identified a known variable, only for it to be found later that he has probably picked up a new variable." This forced Hodge and Wright to rediscover from comparison of original plates most of the ~1800 variables identified in the SMC atlas. In the course of their work they were able to correct many misidentifications made by earlier workers. In addition to the arduous task of certifying the identity of the Harvard variables, they have included identifications for variables studied more recently by Andrews, Graham, van Genderen, and Wesselink and Shuttleworth.

They also provide identifications for NGC, IC, Kron, Lindsay, Westerlund and Glaspey, and Hodge and Wright star clusters, Henize emission objects, Sanduleak supergiant stars, emission-line stars and identified X-ray sources, with cross references when suitable.

The identifications for the various objects are made on 94 visual and 104 blue photographic charts, in a $1\frac{1}{3}° \times 1\frac{1}{3}°$ format at a scale of 16 arcsec mm^{-1}. Two master charts for each colour are included. Some of the charts for the main body of the galaxy are at 5 arcsec mm^{-1} scale, in order to alleviate the problems raised by crowding of the numerous stellar images. The limiting magnitudes for charts beyond the central regions are $V \sim 17.0$ and $B \sim 17.5$; that is, the aim of the atlas is to provide secure identifications for the relatively brighter objects that will receive much of the detailed attention in coming years from the new southern-hemisphere telescopes. The charts are delivered in a sturdy blue box.

A supplementary set of transparent overlays (for sale separately by the Astronomy Department of the University of Washington) provides a rapid way to identify on the charts more distant galaxies and clusters of galaxies in the direction of the SMC, and further extends the utility of the SMC atlas; the objects are those used by Hodge (*Astrophys. J.*, **192**, 21, 1974) in his study of the transparency of the SMC.

The authors have performed an arduous task admirably—the entire astronomical community, and generations of astronomers yet to come, are deeply in their debt.

JAMES E. HESSER