view, and to other natural sciences, in particular, biology. He goes on to consider the implications of the theory of relativity for a consistent picture of the universe. He then deals with the criticisms of Einstein, Bohm, and others. Finally he investigates the effects of quantum theory on theories of matter and on the development of language and logic. The book, originally the Gifford Lectures for 1955–56, is wholly a philosophical treatment, at the so-called semipopular level, of the present state of problems of materialism, existence, and reality in the light of modern physics.

Heisenberg makes the well-known statement that classical physics applies for velocities much smaller than the velocity of light, and for actions much larger than Planck's constant. He goes on to suggest the possibility of a third natural dimension to combine with these two constants, a length of the order of 10^{-13} cm. Then classical concepts would apply only for dimensions much larger than this. To reduce the mental difficulties of picturing atomic events, he suggests applying the Aristotelian concept of "potentia". On this basis pictures in our minds would "represent only a tendency toward reality".

So excellent a book could be considerably improved by the inclusion of even a brief index of the terms used, to indicate the depth of their meaning, and the breadth of their applicability. For instance, what is the variety of examples that make vivid the concept of complementarity? It is unfortunate that Heisenberg's text, marked by clarity and conciseness, should be preceded by an unclear editor's introduction and an unconcise philosopher's introduction.

An Introduction to Scale Coordinate Physics: An Introduction to the Formalization of the Macro Operational Point of View. By William Bender. 340 pp. Burgess Publishing Co., Minneapolis, Minn., 1958. $7.50. *Reviewed by R. Bruce Lindsay, Brown University.*

In this book the author presents what he terms the macro operational point of view in physics. By this he appears to mean the attempt to describe all physical phenomena in terms of quantities immediately measured by laboratory apparatus. He feels that this program can be carried out most effectively by reducing all analytical formulas in physics to nondimensional form. In this process, however, the author retains a special symbol for the dimensional factor and expresses the numeric in the form of the sum of two symbols, one an integer and the other a proper fraction. This has the effect of replacing the single symbol, usually associated with a physical coordinate, with three symbols, or what he refers to as a scale coordinate. The resulting increase in complexity in the writing of the equations of physics is obvious and unfortunately the author does not make clear any compensating gain in clarity or understanding. Most of the book is devoted to a rewriting of physical equations in terms of the new coordinates. There is a good deal of discussion of physical methodology but it is unsystematic, repetitious, and with little or no reference to the large body of literature now extant on the nature of physical theory and physical concepts. Numerous typographical errors render the reading of the book difficult.

Exterior Ballistics of Rockets. By Leverett Davis, Jr., James W. Follin, Jr., Leon Blitzer. 457 pp. D. Van Nostrand Co., Inc., Princeton, N. J., 1958. $8.50. *Reviewed by S. F. Singer, University of Maryland.*

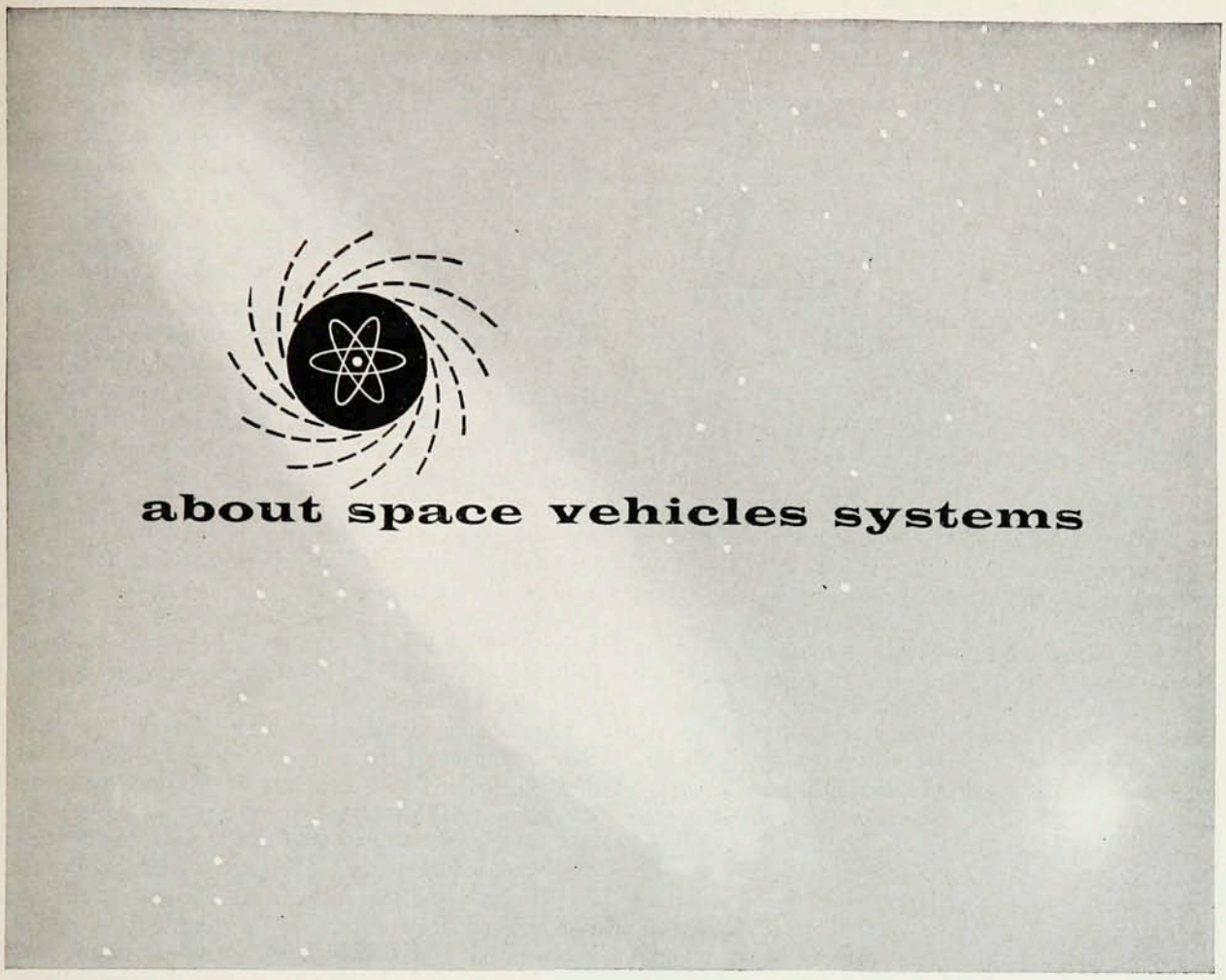
This book develops the ballistics during burning and during atmospheric flight of simple rockets, i.e., rockets having no moving surfaces. It thus deals with rockets whose stability depends either on fins or on spin. The volume, therefore, contains no discussion of servo loops, errors in control systems, etc. There is no treatment of rocket propulsion as such (this belongs to interior ballistics) nor of terminal ballistics. Neither is it a textbook of aerodynamics. (In fact references to drag coefficients and similar aerodynamics data seem strangely antiquated.) Therefore, drag coefficients for a given rocket configuration must be obtained from other sources.

The volume had its origin in the Cal Tech OSRD project during World War II when rapid strides were made in the development of small solid-fuel rockets. The accompanying theory was developed as needed and subsequently published as a classified document. The present volume is a declassified version which has been corrected and to which new figures have been added.

The first half deals with fin-stabilized rockets. The forces acting on the rocket system during and after burning are carefully discussed and then the equations of motion derived and solutions obtained. To give an indication of the detail of the treatment there are sections entitled: Effect of a Constant Linear Thrust Malalignment, and as a subsection: Effect of Launcher Length.

The all-important problem throughout is the dispersion of the rocket, i.e., its accuracy. There are many factors responsible for inaccuracies such as bent fins, moving launchers, and high winds at launching. These and others are discussed in detail and their effects evaluated. If all care is taken, the final inaccuracy is still produced by the nonuniform flow of the rocket gas through the nozzle which gives rise to a thrust misalignment. This in turn causes a torque which points the rocket away from the proper direction. Rotation will average out this thrust asymmetry to a certain extent and larger fins are also helpful since they provide a greater aerodynamic restoring moment. Unfortunately, the fins are not very useful in the critical launching phase since the velocity and therefore the aerodynamic forces are very small. (This latter objection does not apply to aircraft-launched rockets since here the rocket already has a high initial velocity, namely that of the airplane.)

For this reason it is often desirable to spin the rocket extremely rapidly and eliminate the fins altogether.



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While slower rotation can be produced by a rifled launcher, the spin-stabilized rocket requires in general a series of canted jet nozzles. The second half of the book deals with spin-stabilized rockets. After a careful discussion of the force system involved, the analysis of motion during burning and during launching is taken up. Motion during the burning phase is fairly simple since the jet forces are dominant, but the complete analysis of the motion after burning becomes very involved. The authors start by introducing a simplified discussion which gives a physical "feel" of the situation before proceeding to a more rigorous mathematical treatment which includes the more general cases such as precessions with generalized nonlinear aerodynamic moments. There is a lucid discussion of the gyroscopic stability breakdown which occurs if the aerodynamic forces overbalance the gyroscopic forces and cause the spinning body to turn nearly broadside. In fact, the very attractive feature of the book is that in spite of the great complication the discussion is easy to follow, mathematics is kept very simple, and the results are liberally illustrated in the form of graphs.

A few remarks should be reserved for the problem of classification. They form comments on the authors' preface. I think it is a pity that data on various aerodynamic coefficients from NACA reports and from the recent open literature were not included. I don't really believe that "this would raise classification difficulties". Then again: ". . . it is most regrettable that footnote references to (other people's) work are often excluded by security regulations." After 15 years? But these are small points when we consider the authors' ordeal of completing the book under three successive sponsorships (1946–53) which finally resulted in an obscure classified report to be followed by a 3-year declassification procedure. They have performed a real service in making the material widely available. I could really have used this book a couple of years ago when we were concerned with the design of simple unguided high-altitude sounding rockets.

Advances in Geophysics, Vol. 4. Edited by H. E. Landsberg and J. Van Mieghem. 456 pp. Academic Press Inc., New York, 1958. $12.00. *Reviewed by S. A. Korff, New York University.*

As is usual today, in subjects which are in a very rapid process of development, it is difficult to write textbooks which are even approximately up to date. Hence there is much need for a review-type book, which treats in detail various special topics, which will enable the student, or indeed the expert, in one field to become aware of the advances in the adjacent fields which may impinge upon his own. Such a series is *Advances in Geophysics,* of which Volume 4 is the subject of this review.

This book deals with five topics: Atmospheric Chemistry by Christian E. Junge, Theories of the Aurora by Joseph W. Chamberlin, The Effect of Meteorites upon the Earth (including its inhabitants, atmosphere, and satellites) by Lincoln La Paz, The Smoothing and Filtering of Time Series and Space Fields by J. Lieth Holloway, Jr., and Earth Tides by Paul J. Melchior.

The first section deals largely with the "trace gases" in the troposphere, namely such gases as ozone, nitrous and nitric oxides, nitrogen dioxide, ammonia, sulphur dioxide, hydrogen sulphide, methane, and other gases present in small amounts, plus carbon dioxide, which is present in appreciable amounts. The various formation, exchange, and diffusion processes are treated at length. Also he discusses the evidence about nuclei of various kinds in the atmosphere, both solid particles and ionic nuclei which become the centers of condensation for droplets of rain or fog. In the last section, air pollution is treated briefly. All in all, the section is principally a summary of data and chemical processes in the lower atmosphere, and the complex photochemistry of the upper atmosphere is not treated. The discussions are interesting and illuminating. They well illustrate that the atmosphere is much more complex than merely a mixture of oxygen and nitrogen. The physics of small particles, their rates of settling and diffusion are also included. Here both the theory and the actual data are included, so that one can from this account get a pretty good idea of the situation.

The chapter on the aurora starts out with an extensive discussion of the motion of a charge in the field of a monopole; then it goes into the Störmer theory and the various elaborations thereon. Next the more elaborate theories are treated, and the various modifications suggested by Chapman and Ferraro, and by Bennett and Hulburt, and the calculations of Wulf, of Alfven, and of Vestine are discussed. All in all, it is a comprehensive review of the theories. Not much experimental data is presented. About the several theories, this reviewer is left with the distinct feeling that they are excellent intellectual exercise, but only rarely or in small part give a good description of the way nature actually operates. The actual problems are very complex, and the motion of the charged particles generates fields which interact with the fields already present in a manner which cannot be well described by simple theory. Experiments in this field are quite insufficient to date, and one can only hope that the IGY satellite program will yield much more of the type of background information needed before satisfactory theories can be formulated.

The third section, on the effects of meteorites, is largely a review of the known data in this field. Here again, the unsatisfactory situation presently existing in the data is well brought out. From a comparatively small number of meteorites actually recovered, one must estimate numbers, characteristics, and compositions of much larger samples, and extrapolate by several orders of magnitude. The author does a good job in summarizing not only the data, in showing the various disagreements among the various investigators, but in discussing in much detail all the many effects which one might wonder about: does the accretion of such material affect the rate of rotation and dozens of other