But the quantitative data on biological objects are not yet carefully specified. As a result, the quantitative data are only qualitative. The treatment of microcalorimetry is much too restricted to be commended for any purpose beyond a review of the authors' extensive publications.

The Mathematical Foundations of Quantum Mechanics. A Lecture-Note Volume. By George W. Mackey, 137 pp. W. A. Benjamin, New York, 1963. Cloth $7.00, paper $3.95.
Reviewed by Michael Danos, National Bureau of Standards.

At some time during his schooling, every student of physics (at least of theoretical physics) should take out time and indulge in the luxury of exposing himself to the beauty of mathematical thought, to the Olympian remoteness of mathematical problems, to the exquisitely precise filigree structure of mathematical concepts. In addition to the aesthetic pleasure, this digression from the straight path to the PhD can be thought of as a long-term investment that will give the future physicist a new and deeper understanding of the theoretical structure of physics, widen his outlook, and enlarge his horizons.

Mackey's book, an improved version of lecture notes written with élan and lucidity, is eminently suited as an introductory guide into the world of mathematics, as distinguished from mathematical technology, which is usually the only twig of mathematics presented to physics students. In explaining the mathematical structure of classical and quantum mechanics to pure mathematicians having "little or no knowledge of physics", Mackey brings to life what a physicist generally would consider to be abstract and not really useful topics of pure mathematics. The influence of great mathematicians of the past (Poincaré, Hilbert, Weyl, von Neumann) is evident, and the book could be characterized as being a less formal, but more searching, stimulating, and demanding version of von Neumann's 1932 book of the same title. It is aimed at advanced graduate students in pure mathematics. However, a bright advanced graduate student in physics with some knowledge of higher mathematics beyond the college level should be able to gain an understanding of the material presented by the time of the second reading of the book. In the interval between the first and the second reading (since a fault of the book is the paucity of its bibliography) he will have clandestinely approached a trusted member of the mathematics department for help and for advice on the literature, unless he has already done some studying on his own. After this he will return with renewed vigor to the evaluation of his graphs. In the meantime he will not have learned much physics, but he will have learned something about physics.

It may not be pragmatic, but if you are a graduate student, read this book! Perhaps, even you, a mature physicist, should read it!

Solar Flares. By Henry J. Smith and Elske v.P. Smith. (Collier-Macmillan, London) Macmillan, New York, 1963. $12.95.
Reviewed by Bruce W. Shore, Harvard College Observatory.

As a result of the IGY, many physicists discovered the variegated activity on the sun that has fascinated solar astronomers for the last century. Topics that belonged to a few astronomical specialists ten years ago find an audience today throughout the vast new aerospace community. One of the best illustrations is the appearance of this monograph on solar flares—those mysterious unaccountable brightenings of line emission over a small area of the solar disc. Could such an event have any practical consequence? Indeed, yes; major changes of the geomagnetic field often follow disturbances, impairing telegraph and telephone communication. Ionospheric disturbances linked to solar outbursts disrupt radio communication. And as this country prepares to send astronauts on space journeys, these formerly obscure events take on new significance: outbursts of hazardous radiation from the sun appear to be a consequence of major flare activity. Thus, a book on solar flares and related solar-terrestrial relations will attract a sizable and heterogeneous audience, ranging from amateur telescope makers to corporate vice presidents, from hydrodynamicists to statisticians. Each will indeed find this book a readable and interesting treatise. Though an alert freshman may discover possibilities here for a brief research project, theoreticians at the most advanced level will find observations a real challenge, for the basic nature of solar activity is still very much an enigma.

Following an introductory chapter neatly summarizing present knowledge of "the sun's surprising and puzzling behavior," the authors discuss at length the observations of flare phenomena: first the flares themselves, as observed for example through filters; then the spectra of flares and active regions; next radio-frequency observations; and finally corpuscular radiation. The final chapter summarizes the tasks for any model of flare phenomena, and reviews several current models. Readers unfamiliar with stellar atmospheres, observational spectroscopy, or magnetoionic theory will find good introductions to these subjects in the appropriate chapters. The authors carefully define the descriptive nomenclature introduced over the years. An excellent 31-page bibliography and a discussion of the several periodicals devoted to solar data further enhance the value of the book as a reference source.

Henry and Elske Smith have observed and studied flares for several years at the Sacramento Peak Observatory, and this monograph reflects their patient work. I recommend it both for the wealth of data on solar activity and for the well-written detailed description of solar phenomena; it belongs in any well-stocked library of physical science.

The World Of Elementary Particles. By Kenneth W. Ford. 246 pp. Blaisdell, New York, 1963. Paper $2.95., Cloth $4.50.
Reviewed by W. G. Holladay, Vanderbilt University.

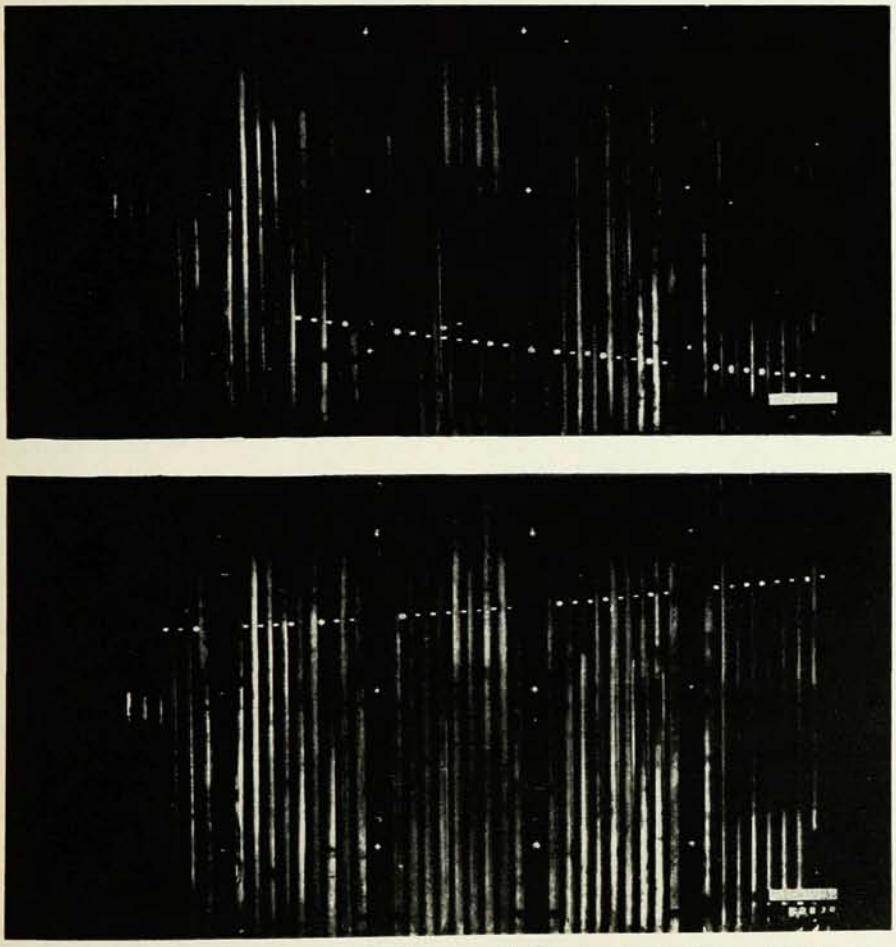
The particles of physics have appeared on the scene in such profusion and usually in such provocative forms that unprecedented effort is being directed toward the attainment of some understanding of their properties. This effort frequently engulfs those involved in it, and since it is at the boundary of our most profound knowledge and deepest ignorance, re-

quires the most erudite and esoteric thought from those who are so involved. The result has been that not enough has been written in recent years on the subject of the "elementary" particles for those who are not acquainted with the most elaborate physical ideas and mathematical techniques. It is most gratifying that a person of Professor Ford's broad knowledge and understanding of this topic has undertaken to remedy this situation.

He discusses in this book *ideas* concerning the nature of these particles rather than the really impressive experimental techniques that have led to those discoveries on which these ideas are based. There are eight chapters, the first being a historical survey of the known particles. The second initiates the uninitiated into the concepts of orders of magnitude of speed, time, mass, charge, and angular momentum as they relate to the particles. The more difficult ideas of relativity and quantum mechanics and their relationship to the particles constitute Chapter 3. Conservation laws and invariance principles add two more chapters (the fourth and eighth). A more detailed exposition of massless particles (photons, neutrinos, and even the graviton) is given in Chapter 5, which is followed by a discussion on the muon-electron puzzle and the properties of the strongly interacting particles and "resonances". The chaotic world of quantum field theory is the theme of Chapter 7, which is liberally interspersed with Feynman diagrams. There are many physicists who feel that the ideas in this chapter will go the way of the phlogiston and the ether, and will probably be inclined to question the emphasis placed on some of the notions discussed there.

Most of the material, which is presented in an engaging and competent fashion with numerous appropriate and original similes, is quite standard, such as the well-known laws of conservation and nonconservation, de Broglie waves, the various quantum numbers of the particles (although he chose generally not to give tables of these numbers for the various particles), equivalence of mass and energy, etc. One somewhat unusual idea is presented, namely that the older view of a fundamental law of nature was that it must be a law of *permission*, whereas, according to the new view (largely originating with studies of particles), the more fundamental law is a law of prohibition and that everything that *can* happen without violating a conservation law *does* happen. The author sees this as democracy in nature—freedom under law—but if the *does* in the last sentence is changed to *must*, one has the Gell-Mann totalitarian principle, everything in nature which is not *forbidden* is *compulsory*.

The book should attract a wide audience. Anyone who can read well and who has any sensitivity at all to the universe as revealed by the natural sciences will be stimulated and informed by it.



Spark-chamber photographs record the discovery of the muon's neutrino at Brookhaven National Laboratory. The tracks are those of muons created when neutrinos were captured in the chamber (from The World of Elementary Particles).

Orbital Dynamics Of Space Vehicles. By Ralph Deutsch. 410 pp. Prentice-Hall, Englewood Cliffs, N. J., 1963. $16.00.
Reviewed by R. L. Street, University of Washington.

As the title indicates, this is not a treatment of celestial mechanics as so many recent introductory texts and one advanced treatise have been. Many of the same topics are included, such as two-body motion, geometry of spatial orbits, determination of orbits, perturbation theory (especially Hansen's method as modified by Musen), and the problem of three bodies. Even these are sometimes treated from a novel and stimulating point of view. In addition new topics such as orbit determination by statistical methods, use of range and time rate of change of range determined by radar and optical tracking methods,