of response, goes unmentioned, but "Skinner box" (p. 353) and "schedules of reinforcement" (p. 354) are mentioned. Admittedly, Pavlov and Skinner themselves have contributed to the kind of confusion reflected in this book, Pavlov by physiologizing and Skinner by emptying the organism and misdirecting his criticisms at the apparatus and procedures of others. Nevertheless, a comprehensive survey of the sort attempted by Altman should do more than perpetuate confusion.

The parallelism in the concluding paragraphs in James's *Principles* (*2*, vol. 2, pp. 688–9) and Altman's text (p. 469) is startling. Both give empirical and logical priority to structure ("nervous system," "neurology"). Both are at great pains to point out how little we know about mental function ("psychogenesis," the "psychic"). Both end on a note of despair (" 'utter night'," and "cannot be resolved"). In view of the despair of both James and Altman, it is my opinion (*6*) that physiological psychologists, indeed all scientists, should consider assigning the same reality status to function as they do to structure.

The feeling one has as one reads the book is that it is a solid (structural) book, solid to heft and solid to own. It contains separate author and subject indices, a 36-page bibliography, lists of suggested general readings, many illustrations, and much information. It should prove useful for teaching and for the researcher who wants to know what has been happening recently in physiological and comparative psychology.

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4. I. P. Pavlov, *Conditioned Reflexes* (Oxford Univ. Press, London, 1927).
5. B. F. Skinner, *The Behavior of Organisms* (Appleton-Century, New York, 1938).
6. W. C. Stanley, "A Mathematical Analysis of the Function-Structure (Wave-Quantum) Problem in Science," in preparation. Compare Dethier's statement that ". . . there is more to the behavior of insects than systems analyses and unit neurological analyses reveal" (*3*, p. 1145).

Mathematical Activity in England

E. G. R. Taylor's **The Mathematical Practitioners of Hanoverian England, 1714–1840** (Cambridge University Press, New York, 1966. 519 pp., illus. $16.50), a sequel to her *Mathematical Practitioners of Tudor and Stuart England* (Cambridge University Press, 1954; shortly to be reissued) is the swan song of a remarkable woman who did much to create the modern science of geography in the early years of this century and subsequently developed a consuming historical interest in cartography and navigation. Her *Haven-Finding Art* (1957) will be familiar to many, and indeed it was as an offshoot of her researches into navigational techniques, maps, instruments, and teaching methods in post-medieval England that her interest in the lower echelons of practicing mathematicians developed.

Taylor's earlier volume on mathematical practitioners struck a rich vein in chronicling en masse the many mathematics teachers, textbook writers, map- and instrument-makers, and engineers who during the 16th and 17th centuries, it could be argued, laid the foundation for England's maritime supremacy and scientific prominence by 1714. Skillfully filling in the background of a period she knew so well, Taylor unearthed a great deal of informatory detail relating to the life and work of the humble practitioners to whom she was determined to accord due recognition. The pattern she there established, in which a set of prefatory general essays introduce a series of lists of potted biographies and a calendar of books and pamphlets published, is now (with some modification) repeated in this continuance of the story up to 1840. Over the preceding century and a quarter the careers of some 2270 who, for want of a better phrase, "practiced" mathematics are traced. Taylor, it would be fair to say, does not refute the accepted view that 18th-century England was a mathematical backwood, but at least she reveals that the wood was alive with activity, not usually well directed, of all kinds.

The two volumes share a basic weakness. The mathematical practitioners they study were never more, at any time, than an ill-assorted, motley group with no real unifying bonds of education, social class, political influence, or intellectual parity: indeed, they achieved true identity only about the beginning of the 19th century when they splintered into the autonomous professions of surveyor, architect, engineer, actuary, draftsman, and others. The net which seeks to trap discordant elements must perforce be both wide and full of holes. Taylor has inevitably, in her determination to miss not a one, caught some surprises in hers, from Isaac Newton and Benjamin Franklin down to William Herschel and the infamous Captain Bligh of the *Bounty*, but has lost, for example, the émigré Huguenot Abraham de Moivre, who trod the streets of London many long years between the houses of his pupils. In the more conventional entries, too, a certain incompleteness of information and false emphasis are apparent. (We are not told that John Harris in 1702 wrote the first vernacular tract on fluxions or that Edmund Stone's greatest gift to his contemporaries was his English version of L'Hôpital's *Analyse*.) On the whole the fine, flowing prose of the more general essays hides their tendency to be mere scrappy running commentary on particular events or situations (the activities of the Admiralty's Board of Navigation, typically, or particular refinements in contemporary instrumentation). No profound assessment is made of the dampening effect of the lack of systematic mathematical education in either school or university, or of the cumulative influence of the writers of popular textbooks in bowdlerizing mathematical taste. Like its predecessor, the newer book will find its main use as a directory but is not adequate to do more.

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Statistical Mechanics

During the last few years the literature on general statistical physics has been enriched by various contributions. It is, however, only in relatively few of the monographs that one finds a serious attempt towards a synthesis of the macroscopic concepts of non-equilibrium thermodynamics and the concepts of statistical mechanics based on the ensemble theory. Wolfgang Yougrau, Alwyn van der Merwe, and Gough Raw's **Treatise on Irreversible and Statistical Thermophysics** (Macmillan, New York, 1966. 288 pp., illus. $9.95) constitutes a valuable attempt in this direction. At the same

time it provides a text which is intermediate between the more detailed books, such as Landau and Lifshitz's *Statistical Physics*, and Kittel's highly instructive, but rather short, *Elementary Statistical Physics*.

The *Treatise* may be divided into three main parts. In the first part, corresponding to chapter 1, the authors present an outline of irreversible thermodynamics as formulated by Onsager, Prigogine, and Meixner. Particular emphasis is given to Onsager's reciprocity theorem, which is illustrated by a very instructive example from chemical kinetics.

The remaining two parts of the book are mainly devoted to a presentation of equilibrium statistical mechanics as based on ensemble theory. Some kinetic theoretical problems, such as master equations and H-theorem, are discussed briefly in sections 2.8 and 2.9, but otherwise the first part of the book seems only loosely connected with the remaining two parts.

The second part (corresponding to chapter 2) is devoted to a careful discussion of equilibrium statistical mechanics. It includes topics such as Liouville's theorem and the ergodic problem, as well as the theory of different classical and quantum-mechanical ensembles. Particular emphasis is given in the discussion of the general principles. A nice presentation of the counting problem and the $N!$ discrepancy is given separately in an appendix.

In the last part (chapters 3 and 4) the authors present various applications of equilibrium statistical mechanics to systems consisting of simple molecules, as well as to systems possessing internal degrees of freedom. In chapter 3 in particular, the thermodynamic properties of Fermi-Dirac and Bose-Einstein gases are evaluated in some detail. Some applications to the electron theory of metals and to the theory of black-body radiation are also included. In chapter 4, the theory of diatomic ideal gases is outlined, and elementary excitations in condensed bodies (solids or superfluids) are discussed.

A collection of problems, very carefully chosen, serves to illustrate the different subtle points in the theory or to give an indication of some of the topics not included in the book. This monograph constitutes a useful critical presentation of general statistical physics at a intermediate level.

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Analytic Uses of Luminescence

Fluorescence has been an important technique of the analytical chemist for many years but has not attained the place that it should have in the characterization and identification of organic compounds. **A Handbook of Fluorescence Spectra of Aromatic Molecules** (Academic Press, New York, 1965. 268 pp., illus. $8.50), by Isadore B. Berlman, should prove an incentive to the organic chemist to report the fluorescence spectra of new compounds as an additional means of identification. In this book Berlman gives 147 full-page illustrations of the absorption and fluorescence emission spectra of a variety of aromatic compounds. The legend on each graph gives the name of the compound (and, in many cases, the formula), the solvent, the concentration, the exciting wavelength, the slit width, the emission in average and center-of-gravity values, quantum yield, lifetime, and Stokes losses. Unfortunately, these legends were apparently poorly printed from the computer cards and are difficult to read. The fluorescence emission curves are corrected for the response of the Beckman DK-2 spectrophotometer which was used in the measurements. In using these curves the reader should note that the authors have covered only a particular set of wavelengths and have made no attempt to show the absorption curve below specific points, for example 250 millimicrons. In the case of quinine sulfate, this fails to show the strongest absorption curve and hence the best excitation point. The first chapters of the book discuss effects of solvent, temperature, and concentrations. Thirty pages in the appendix are devoted to a classified bibliography chiefly on the physical aspects of fluorescence. Many of the compounds described are used as scintillators; hence, this book will find considerable use as a reference by physicists as well as chemists. The author and publisher have done a real service to the science of fluorescence in publishing the corrected spectra data on such a large number of compounds.

The material in **Fluorescence and Phosphorescence Analysis: Principles and Applications** [Interscience (Wiley), New York, 1966. 272 pp., illus. $12] is an expansion of eight papers presented at a symposium at the 1964 meeting of the American Chemical Society, and the title well represents the content of the book. Each paper is presented in a separate chapter and the whole is edited by David M. Hercules, who presents the first chapter on the theory of luminescence processes.

This is followed by successive chapters, on instrumentation by David W. Ellis, the fluorescence and phosphorescence of organic molecules by E. L. Wehry and L. B. Rogers, metal chelates by William E. Ohnesorge, analytical uses of phosphorescence by J. D. Winefordner, chemiluminescence by J. P. Paris, fluorescence in biomedical research by B. L. Van Duuren, and polarization in solution by Gregorio Weber. Each of the chapters serves as an introduction to the subject it treats, and each contains an excellent group of references. The authors are well versed in their respective topics and present the material in clear, condensed style. No specific analytical procedures are included, for this is not the intention of the authors. The limits of detection of 46 drugs and biological compounds by phosphorimetry are given in a table. The excitation and emission maxima of several pyrenes in potassium bromide pellets are listed. This book is recommended for anyone working in the areas of fluorescence and phosphorescence. It will also serve as an introduction for those who wish to become acquainted with this important field of analysis.

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Economics of Minor Metals

Supply and Competition in Minor Metals (Johns Hopkins Press, Baltimore, 1966. 155 pp., illus. Paper, $3) by David B. Brooks is another fine book in the series produced by Resources for the Future. Its tables and figures bring together new data unavailable elsewhere, are highly informative, and will be useful.

Brooks defines the minor metals as "those metallic elements that are beyond the laboratory stage but are recovered each year in less than major metal tonnage or value; they are industrial commodities produced on a continuing basis, not just metals recovered for experimental or non-commercial purposes." He has devised what seems to be a logical and workable classification of these metals as: metallurgical by-products of major metals; milling by-