there are no references, the material being largely classical, the preface acknowledges the influence of De Bruijn's lecture notes and the books of Halmos and Saks.

Part II (7 chaps., 364 pp.), the meat of the book, is devoted to "Bounded transformations and compact transformations in Banach space and Hilbert space." Except for the terse survey of Banach spaces in the early part of Hille's *Colloquium Lectures,* there has been no detailed treatment of either Banach or Hilbert space since the treatises of Banach and Stone in 1932. The attractive development given here will be valuable as a textbook for students and as a standard reference for the expert. The reader is referred to the monographs of Nagy and Halmos for detailed discussion of more general transformations in Hilbert space.

To begin with, the rudimentary properties of Banach and Hilbert spaces are proved and illustrated. Separability is usually not assumed, and there are several results in which completeness of the space is not assumed.

In the treatment (chap. 7) of bounded linear transformations, the theorem (Ext.) on extension of bounded linear functionals is basic. This theorem can be proved in a separable Banach space or in a Hilbert space without appealing to the Axiom of Choice. Here the author renounces the Axiom of Choice entirely, and assumes Ext., when needed, as a further postulate. The discussion includes results on the first and second adjoint spaces, weak convergence, closed transformations, the adjoint transformation, and projections.

A concise algebraic account of finite-dimensional spaces is carried through the Hamilton-Cayley theorem and the (Jordan) canonical form.

Chapter 9 is devoted principally to bounded self-adjoint transformations in Hilbert space. One also finds here a substantial introductory discussion of linear integral transformations. The latter part of the chapter discusses symmetrizable and normal transformations and closes with a presentation, following F. Smithies, of the Fredholm theory for a linear transformation T of a separable Hilbert space into itself such that $\Sigma_{ij} \mid (T\varphi_i, \varphi_j) \mid^2 < \infty$, where φ_j is a complete orthonormal system.

Next the author studies the range, nullspace, and spectral properties of bounded linear transformations on one Banach space into another, extending the results on these topics given in earlier chapters.

The long Chapter 11 treats compact transformations on one Banach space into another. A transformation is compact (formerly "completely continuous") if the map of bounded set has a compact closure. One misses here at least some mention of approximating a compact transformation by a transformation with finite-dimensional range. The Riesz-Schauder theory is given for a transformation T with a compact iterate. Further results in Hilbert space are presented, and the chapter closes with two mean ergodic theorems.

The final chapter of part II is devoted to compact symmetrizable, self-adjoint, and normal transformations in Hilbert space. The emphasis is on spectral properties, and the minimax relations and expansion theorems are developed in detail.

Part III (5 chaps., 136 pp.), entitled "Nonsingular linear integral equations," will be of particular interest to specialists in that branch of analysis. Roughly half the space is devoted to general theory (spectral properties, resolvent, expansion theorems, and so forth), with numerous applications of the material developed in part II. Remaining chapters treat normal kernels, symmetrizable kernels, and kernels of Marty, Garbe, and Pell. Although the original contributions of the author in part II are substantial, in part III they are very conspicuous, and his treatment clearly indicates the progress that has been made since the initial work on these particular questions.

The general theory of linear topologic spaces is omitted, along with non-linear and unbounded linear transformations.

By concentrating on his chosen objectives, however, Zaanen has been able to dispose of them in an unusually thorough way. The book is enriched with numerous examples and much illuminating comment. Many chapters are followed by long lists of valuable exercises with generous hints. The few typographic errors noted are trivial. This book is meticulously written, at a very high level of explicitness, and the prerequisites are so modest that an intermediate graduate student should be able to use it with little assistance. The author has met in a very satisfying way an urgent need in the expository literature.

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The Statistical Approach to X-ray Structure Analysis. Vladimir Vand and Ray Pepinsky. Pennsylvania State Univ., State College, Pa., 1953. xvi + 98 pp. Illus. Paper, $1.50.

A proper solution to the phase problem of x-ray crystal structure analysis—that is, the problem of somehow supplying the phases of the Fourier coefficients of a crystal structure to accompany the experimentally measurable magnitudes—would be an achievement of the highest importance, for it would make the complete and precise structure determination of every crystallizable substance a routine matter. Only a few months ago a monograph appeared [*The Solution of the Phase Problem,* pt. I, *The Centrosymmetric Crystal.* H. Hauptmann and J. Karle, American Crystallographic Assoc. Monogr. No. 3. The Letter Shop, Wilmington, Del. (1953)] that seemed to provide this long-sought solution. Hauptmann and Karle's method is a statistical one; they take advantage of the fact that there are more magnitudes known than are strictly necessary to characterize the structure to obtain the most probable value for each of the phases.

Almost immediately objections were raised, and they have found their strongest statement in the pres-

ent monograph by Vand and Pepinsky. These authors agree that, except for certain approximations that are probably of little importance, Hauptmann and Karle's derivation is correct. But they claim that the most probable phases will not always be the true phases and, moreover, that the discrepancies will not be random but systematic and of such nature as to produce in general an incorrect structure, resembling the Patterson function (self-convolution) of the structure more than the structure itself. In a simple case that they present this is indeed what happens, but their case may be too simple to meet the basic requirements of any statistical method.

The controversy is by no means settled yet. But such a controversy, if pursued in good spirit, can benefit the science greatly. Vand and Pepinsky's monograph is a case in point. They have presented their case admirably, and they have put forward a considerable number of new ideas.

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Mammalian Hybrids. A check-list with bibliography. Annie P. Gray. Commonwealth Agricultural Bureaux, Bucks, Eng., 1954. 144 pp. 21s.

This annotated compilation of records of hybridization of mammals lists more than 300 cases, a surprising number. It is also surprising how many of these hybrids have been fertile.

A bibliography of more than 600 titles and an excellent index are included. There are interesting notes on behavior, fertility, and physical characters.

Naturally, in a work of this sort there are a number of omissions, but this book will be welcomed by biologists, especially those interested in mammalian genetics, as a reference and as a guide.

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Autotrophic Micro-organisms. Fourth Symposium of the Society for General Microbiology held in April 1954. B. A. Fry and J. L. Peel, Eds. Cambridge Univ. Press, New York, 1954. ix + 305 pp. Illus. $5.

In the beginning there must be synthesis. Autotrophic microorganisms are independent of the more elaborate forms of carbon compounds, being able to live and multiply in an environment containing carbon dioxide as the sole source of carbon. Many organisms may live autotrophically—others have to. In this book a group of scientists from Britain, the U.S.A., Norway, and Holland record the discussion at a meeting in London regarding the physiology, biochemistry, metabolism, production, and economic importance of these organisms. Early chapters simplify the nomenclature, describe connections with other types of organisms, and show that although simple in the nutritional sense the autotrophs have a greater range of biochemical accomplishment than any other living creatures. Later chapters delineate present knowledge of these simple and mainly aquatic bacteria and algae and indicate many possibilities for the development of this knowledge in the future. Thiobacilli, nitrifying bacteria, blue-green algae, photosynthesis, the utilization of organic compounds, and energy relationships are dealt with in turn.

The economic importance of the autotrophs is discussed in the final chapter. By accumulation of chemical energy by the phytoplankton (photoautotrophs), by the nutrition of higher green plants, by improvement of eroded soils, by sewage disposal, by increasing the yield of fish, or by the production of sulfur, they can or may in the future be of great use. Destructive effects such as corrosion of iron, ships, rubber, and cement, and the occasional mass mortality of fish, are dealt with.

This is a valuable collection of data for workers in this field. Its interest to others arises both because of the substantial conformity that these microorganisms show in their metabolic pattern with all forms of life and because of the occasional striking biochemical differences that are present. The book, well produced and well written, has accomplished its aim of providing an account of the present position in this expanding field of knowledge.

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Elements of Food Engineering. vol. II: *Unit Operations.* Milton E. Parker. With the collaboration of Ellery H. Harvey and E. S. Stateler. Reinhold, New York, 1954. vi + 360 pp. Illus. $8.50.

This is the second volume of a three-volume series. In the first volume, published in 1952, the authors described different classes of refined food products and *what* is usually done in the way of processing to produce the product. Processing equipment was only incidentally mentioned. This second volume places more emphasis on *how* the processing is done.

The 10 chapters (chapters 14–23) in this volume cover unit operations concerned with assembly, preparation, and conversion of raw materials. The book is profusely illustrated with pictures and diagrams showing typical equipment and processing layouts for operations in a diversified group of food industries. For example, the cleaning of raw materials is illustrated by pictures and diagrams covering gyrosifters, Entoleters, spinach dry cleaners, automatic bottle cleaners, hydraulic scrubbing equipment, whirlpool washers, air purifiers, filters, clarifiers, and so forth. The treatment is descriptive rather than critical.

The authors have assembled a large and diversified list of standard pieces of food processing equipment, along with descriptions of how each fits into normal commercial operations. This should provide undergraduate students of food technology with an excellent introduction to the broad scope of food process-