periments, the product of the malate synthetase reaction was isolated by paper chromatography and shown to have identical R_f's in several solvent systems as authentic malic acid. Malate was further characterized by use of the malate decarboxylating enzyme obtained from *Lactobacillus casei*[5] and by partially purified preparations of fumarase obtained from *E. coli*.

The precise mechanism of the reaction is under investigation.

(5) M. L. Blanchard, S. Korkes, A. del Campillo and S. Ochoa, *J. Biol. Chem.*, **187**, 875 (1950).

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BOOK REVIEWS

Progress in Low Temperature Physics. Volume I. Edited by C. J. GORTER, Professor of Experimental Physics, Director of the Kamerlingh Onnes Laboratory, Leiden. Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, N. Y. 1955. xii + 418 pp. 16 × 23 cm. Price, $8.75.

When the scale of absolute temperature was first proposed by Kelvin, the concept of an absolute zero as the ultimate point of zero thermal energy implied, superficially at least, that the region of very low temperatures was a kind of grave-yard where nothing happened. Thus, it was quite a shock to learn through the discovery by Kamerlingh Onnes of superconductivity with its frictionless circulation of electrons that in this realm of eternal atomic rest there appeared the closest thing yet found to perpetual motion. This initial paradox has been followed in the course of years by a series of others in some ways even more startling; such as, absolute diamagnetism and the superfluidity of helium. So today we see clearly that in the region of very low temperature we have one of the great frontiers of science across which there is a vista of one of the strangest domains of phenomena known to man. How far removed it is from familiar ground can be seen by considering that high temperatures commonly used in the laboratory lie above room temperature only by a factor of ten, while the lowest temperatures now available through adiabatic demagnetization represent a decrease on the absolute scale by a factor of ten thousand.

It is fitting that this review of low temperature progress should be initiated at Leiden and edited by Professor Gorter, the present director of the Kamerlingh Onnes Laboratory where the first great spear-head of exploration in this field was launched; and the quality of the book is on a par with the quality of the work which has made Leiden the capital of the cryogenic realm. There are eighteen articles, each by an outstanding authority, with the topics selected to provide discussion of the major fields of interest, and the treatment planned to give an integrated presentation with a minimum of duplication. This, of course, brings forth summaries, some aimed almost exclusively at theory, some almost entirely on experimental developments, some in between, and all filling an unusual need, because the activity in both the theoretical and experimental phases of low temperatures is intense; and there has been no adequate general review for a long time.

The titles and authors of the articles give the best brief summary possible of the scope of the book:

I. C. J. Gorter, The Two Fluid Model for Superconductors and Helium II
II. R. P. Feynman, Application of Quantum Mechanics to Liquid Helium
III. J. R. Pellam, Rayleigh Disks in Liquid Helium II
IV. A. C. Hollis Hallett, Oscillating Disks and Rotating Cylinders in Liquid Helium II
V. E. F. Hammel, The Low Temperature Properties of Helium Three
VI. J. J. M. Beenakker and K. W. Taconis, Liquid Mixtures of Helium Three and Four
VII. B. Serin, The Magnetic Threshold Curve for Superconductors
VIII. C. F. Squire, The Effect of Pressure and of Stress on Superconductivity
IX. T. E. Faber and A. B. Pippard, Kinetics of the Phase Transition in Superconductors
X. K. Mendelssohn, Heat Conduction in Superconductors
XI. J. G. Daunt, The Electronic Specific Heat in Metals
XII. A. H. Cooke, Paramagnetic Crystals in Use for Low Temperature Research
XIII. N. J. Poulis and C. J. Gorter, Antiferromagnetic Crystals
XIV. D. DeKlerk and M. J. Steenland, Adiabatic Demagnetization
XV. L. Neel, Theoretical Remarks on Ferromagnetism at Low Temperatures
XVI. L. Weil, Experimental Research on Ferromagnetism at Very Low Temperatures
XVII. A. Van Itterbeek, Velocity and Absorption of Sound in Condensed Gases
XVIII. J. De Boer, Transport Phenomena in Gases at Low Temperatures

Considering the current interest in the theory (superconductivity and superfluidity are still unsolved riddles) it is a pity that a few of the exceptionally good articles like Feynman's could not have been made two or three times as long. It would have been good to include also at least one article on the basic meaning of low temperature *per se*. It would also have been good to have a special discussion of the bearing of recent cryogenic work on quantum statistics, especially that part closely associated with the Third Law of Thermodynamics and of special interest for physical chemistry. But, since as Gorter says, low temperature is concerned with at least some paragraphs in every chapter of physics, one cannot ask for completeness short of a multivolume handbook. For that reason it is to be hoped that future volumes of this new series will appear regularly and frequently.

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Small-Angle Scattering of X-Rays. By ANDRÉ GUINIER, PROFESSOR, Université de Paris (France), and GÉRARD FOURNET, LECTURER, Ecole Supérieure de Physique et Chimie, Paris. Translation by Christopher B. Walker, Institute for the Study of Metals, University of Chicago. Followed by a bibliography by Kenneth L. Yudowitch, Johns Hopkins University. Structure of Matter Series. Maria Goeppert Mayer, Advisory Editor. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. 1955. vii + 268 pp. 15.5 × 23.5 cm. Price, $7.50.

This is the first book in a recently developed branch of X-ray analysis which promises to be of considerable interest, particularly to chemists, biologists and metallurgists. The earliest quantitative work was done about 1939 by Professor Guinier, the senior author. Since then several hundred papers have appeared and instrumental and interpretive techniques have developed to the point where attention can

shift from the method to the applications. The principal application is to the elucidation of structure on the colloidal level.

Although small angle X-ray scattering is now a fairly well established research tool, a first book should nonetheless attempt a wide coverage. The authors have succeeded in this, not only in the subject matter but also in the level of the treatment. The first two chapters (more than a third of the book) present a careful and expert discussion of the theoretical background. Especially valuable is the material on the scattering from dense systems, that is, systems in which interparticle interferences are important. Even at low concentrations of macromolecules in solution interparticle interference effects may distort the single particle scattering function and complicate the measurement of the radius of gyration. At high concentrations structure is introduced into the scattering curve which characterizes the relative spatial distribution of the molecules but which has been interpreted in too simplified a manner by many workers. Much of the material on dense systems will be interesting to physical chemists using light scattering techniques. They are accustomed to a thermodynamic rather than a geometric interpretation of concentration effects, but the problem is essentially the same. In fact a very promising but still undeveloped application of small angle X-ray scattering is the use of interparticle interference effects to determine molecular interactions.

The third chapter treats of experimental equipment. There is a good general discussion of the conflicting requirements of high intensity and high collimation of the X-ray beam and details of nearly all the collimators, scattering chambers and detecting devices which have been used successfully. This chapter includes also some very useful material on the correction of scattering curves for the finite size, particularly the height, of the apertures defining the beam.

The remaining chapters on the interpretation of experimental results and on applications again constitute somewhat more than a third of the book. The exposition is less mathematical than in the first two chapters but covers much of the same ground emphasizing, of course, the material most useful to the experimentalist. Here again the authors perform a notable service in warning against the dangers of over-interpretation of X-ray data.

It may be of interest to mention in greater detail the last chapter on applications. Up to this point the monograph is written for those who have a serious interest in learning of, and presumably using, small angle X-ray techniques. The last chapter is for the more casual reader. It will furnish a quick survey of the fields in which small angle X-ray scattering has been found useful, and spare him a great deal of wandering through a well scattered literature. These applications include the determination of size, shape and interaction of macromolecules in dilute solution, the measurement of long periods and partially ordered arrangements of micelles in natural and synthetic fibers, the measurement of size and surface area of commercial catalysts (this is now a routine procedure in some laboratories) and a large number of uses in physical metallurgy. In the latter field the method is particularly well suited to the investigation of the very early stages of the precipitation of a new phase, before changes are obvious under the microscope.

The authors have brought up to date and reprinted the 1952 bibliography on small angle X-ray scattering of the American Crystallographic Association. It contains almost six hundred titles, frequently followed by a descriptive sentence or two. The typography and the translation are excellent.

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Lithium Aluminum Hydride in Organic Chemistry. Monographs. Volume CCXXXVII. Section for Natural Sciences and Mathematics. No. 9. Edited by KOSTA V. PETKOVIC, Member of Academy, Secretary of the Section for Natural Sciences and Mathematics. By VUKIC M. MICOVIC, Ph.D., Professor of Chemistry in the University of Belgrade (Faculty of Sciences) and MIHAILO LJ. MIHAILOVIC, Ph.D., Lecturer in Chemistry in the University of Belgrade (Faculty of Sciences). Servian Academy of Sciences, Knez Mihailova 35, Boegrad, Yugoslavia. 1955. xi + 193 pp. 17.5 × 24 cm. Price $3.00.

Here, at a price within reach, is a review (in English) of the synthetic applications of lithium aluminum hydride. It is a concise, factual representation of the literature (1732 literature references) up to mid-1954. The flood of literature on this subject has probably reached its crest (*cf.* Fig. 1,

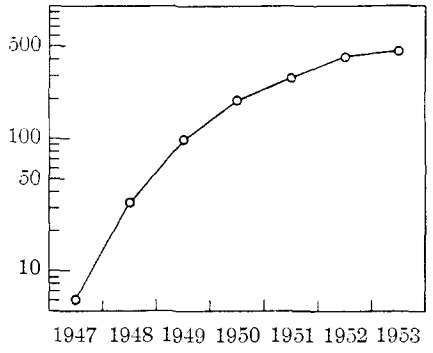

Fig. 1.—References cited 1947–1953.

showing distribution of references by year) and it is fair to say that the main outlines in the synthetic applications have been adequately delineated. The deviations from the normal pattern of reaction are already sufficiently numerous that one has no doubt the mechanistic problems will occupy the attention of physico-organic chemists for some time to come.

In a brief foreward Professor Schlesinger gives the work his blessing.

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Molecular Beams. By K. F. SMITH. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. 1955. x + 133 pp. 11 × 17 cm. Price, $2.00.

This little book by Dr. Smith gives an admirable account of many of the advances in the molecular beam art which have taken place since the publication by Methuen and Co. of a similar book authored by Ronald Fraser in 1937. One certainly welcomes this present edition; on the other hand, the 18-year intervening period has been long and the expansion from 66 to 127 pages of text does not appear to the reviewer to have been adequate. Thus there results a book covering the newer resonance techniques in insufficient detail to satisfy the needs of a man who wishes to enter the field; yet it is not sufficiently comprehensive in covering, in a reference fashion, the work of the intervening years so that the book can serve unfailingly as a guide to detailed accounts in the scientific literature. One hoped for a comprehensive and reasonably exhaustive treatise on the subject of molecular beams. Such a treatise should include in considerable detail the various aspects which deal with the processes of production of beams. Fraser's 1937 Cambridge University Press book entitled "Molecular Rays" has much more in it on these phases than the present book or its predecessor. Yet many of the things regarding mean free path-slit width criteria, more or less taken as gospel until recently, are now being re-examined and some discussion is in order, if for no other reason than to show how little we actually do know regarding the elementary process of effusion.

In spite of these limitations the present book definitely fills a well-felt need and the author is to be commended on his ability to cram so much into such a few pages and yet do it in a clear and understandable fashion. The first chapter covers the production and measurements of molecular beams, particularly the latter where the newer methods of beam detection are discussed. The second chapter includes a discussion of the velocity distribution in a beam and the deviations from the $v^3e^{-v^2/\alpha^2}$ law which can and do occur. A very interesting review of the use of atomic beams in optical spectroscopy is also included. Chapter III covers experiments on the wave nature of particles, crystal cleavage plane diffraction effects and beam scattering phenomena.