may be brought readily into the temperature region of a degree or so above absolute zero, a fact that has led to a vast amount of solid-state and nuclear research, ingenious devices and the prospect of future discoveries of limitless scope between 4 K and absolute zero (as long as we humans conserve our helium resources—a proviso that requires eternal vigilance and that supplies much food for thought in the light of present US consumption, that is, loss, of one billion cubic feet per year).

Two decades ago, as the postwar proliferation of cryogenics laboratories got slowly under way, the specialist library in the subject ran to a mere handful of volumes. Of these, no other matched in size, scope and importance the famous monograph *Helium* of the late W. H. Keesom. For a long time thereafter the growth of the field far outpaced that of the hardback literatures, but in recent years a balance has been largely restored. One has had to wait for a new "Keesom"—until the appearance now of *The Properties of Liquid and Solid Helium* by John Wilks.

The author does not claim supplantation as his actual aim, but rather presents a survey of the properties of liquid and solid helium in light of modern knowledge, with the exercise of judicious selection of articles for detailed discussion, and concentration "principally on basic features that illustrate fundamental principles." The result is the same. With this massive (700 pages) and impressive book Wilks skillfully and essentially exhaustively covers the subject in its modern complexity up to 1965–66. The pace of current developments rules out the possibility of producing another "Keesom" in completeness and durability, but this new volume suffers nothing by comparison in terms of authority and educational value.

Major experimental findings are clearly described and supported most adequately with details of apparatus and techniques, graphs and schematic drawings. Wilks treats theoretical developments mostly in outline, with summaries of the main results obtained, to preserve clarity of exposition for the average reader and manageable bulk for the book. The original papers and major review articles are fully referenced, and one notes that contributions from Russian authors—which are numerous and important—are very thoroughly covered.

SMALL BAR MAGNET floating on its own magnetic field. The frosted lead dish beneath it has been made superconducting by immersion in liquid helium at 4 K; the field lines excluded from the superconducting material levitate the magnet. This photograph was made at the Lewis Research Center of NASA.

Wilks himself is a well known specialist in cryogenics research, particularly active in the study of transport processes in liquid and solid He^4 and liquid He^3. The concerns of both careful experimentalist and experienced teacher emerge from these pages, and though the style is a trifle laconic the text is still very readable. Some economy of words was, in any case, highly necessary to restrict a thorough (up to 1965) coverage of He^4 and He^3 to some 450 and 150 pages, respectively. (There is also one chapter each on the subjects of dilute solutions of He^3 in liquid helium II and phonons in crystalline solids.) The latter treatment, of the light isotope of helium in liquid and solid forms, covers a field of research in existence but 20 years and hence unknown to Keesom and pre-World War II researchers. Here some of the most fascinating studies are restricted to the region of very low temperatures, 0.001 to 0.01 K, and thus are still very much the private fief of a very few laboratories, paralleling the situation concerning liquid He^4 in the 1930's.

I believe that students and lecturers will find this volume indispensable and that the author has ample grounds for satisfaction with a splendid contribution to the literature of low-temperature physics.

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The reviewer, a former chief of the cryogenic-physics section, National Bureau of Standards, states that his review is as determinedly objective as his having been a student of the author can allow.

Applications of lasers

LASER SYSTEMS AND APPLICATIONS. By Herbert A. Elion. 624 pp. Pergamon Press, Oxford, 1967. $22.50

by David F. Hotz

Over the past eight years a very great investment has been made in the development of lasers. This investment has been so successful that its sponsors suffer from an embarrassment of riches. One realizes the magnitude of return when one remembers that ten years ago a coherent optical source was hopeful speculation and today such sources are available all over the traditional optical spectrum ranging from the ultraviolet to the far-infrared region. A well known wit in the field has characterized the laser as a solution looking for a problem, a pithy statement that conveys both an appreciation for the potential of the laser and an impatience with the pace of application appropriate to the capabilities of the device. This state of affairs presages a shift of emphasis towards the peripheral apparatus and accessories capable of exploiting the unique properties of this new radiation source. This shift will very likely

go hand in hand with more complex applications. The prospective audience is potentially broad; it ranges from medicine and biology through the information sciences to all traditional branches of engineering.

Elion's book emphasizes laser systems and applications, which is appropriate in view of the author's background in analytical instrumentation. The first five chapters review fundamentals, historical background and the various types of lasers currently available. Chapters 6 through 12 are the heart of the matter. Chapter 6 is a muddled, rambling piece ostensibly concerned with modulation. It is puzzling why waveguide properties of optical fibers and inversion by optical pumping are included. The energetic applications discussed are mainly concerned with burning and damage ranging from medical and dental applications to metal working and welding. It is of course compulsory that a book on this subject discuss holography. The treatment here is brief but good and contains some excellent work originated by the author's colleagues. Distance determination by fringe counting and time of flight are discussed as well as velocity and angular velocity measurement. The chapter on communications is a disappointment and includes superfluous articles on multiplexing and phase locking. "Optical Data Processing and Display" includes a discussion of various deflection schemes for display purposes, modeling, analog methods of analysis and applications to digital computation. Chapter 12, "Present and Future," is a potpourri of undigested facts and the last word as derived from trade publications. The third paragraph on page 178 is a jarring example of the type of incomprehensible paragraph that unfortunately occurs too frequently to be overlooked. The first four appendexes form the most valuable part of the book. Appendix 1 is essentially a set of safety rules recommended by the Martin Co. These rules consist mainly of common sense plus a large dose of caution. Appendix 2 is a reprint of the educational pamphlet published by Optics Technology Inc., entitled "Experiments in Physical Optics Using Continuous Laser Light." Appendix 3 is a listing of some of the materials in which stimulated Raman emission has been observed. Appendix 4 is a compendium of laser-source characteristics reprinted from an industrial publication. Appendix 5, comprising 56% of the book pagination, is a reproduction in part of a NASA bibliography in computer-generated format. It is difficult to see how this bibliography can be of much value to a wide audience since it is not a self-contained guide to the literature but instead a guide to a set of abstracts. Many of the entries are available only as technical reports of government-contract work, and those familiar with such publications are aware of their shortcomings as a form of technical literature.

It is understandable that the cited examples of applications reduced to practice are weighted towards industrial advertising literature. They claim 50% of the illustrations while 18% are credited to the open technical literature. Missing, however, are discussion and comparison of relative merits of competing schemes. An uncritical journalistic description of a limited sample of applications presented in the vernacular of the trade publications will not teach the reader how to conceive his own application although it may whet his desire for a better understanding of the laser and its applicability and limitations than is displayed in this work. The author states in his preface that one of his greatest struggles was to reduce the number of mathematical formulas while explaining the physical phenomena. His success is limited to a suppression of mathematics since only four numbered equations appear in the entire text. The writing is of uneven quality; it illustrates the style of a team-written contract proposal badly done. The work lacks cohesiveness and gives the impression of not having been edited.

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The reviewer is an experimental physicist with the US Naval Electric Laboratories. He is mainly concerned with the development of lasers.

Quantum oscillators

MASERS AND LASERS: PHYSICS AND DESIGN. By J. S. Thorp. 312 pp. St. Martin's Press, New York, 1967. $8.50

by Mary E. Cox

"This book has three main objectives. Firstly, to give an account of the essentials of masers and lasers suitable for undergraduate study. Secondly, to provide for the post-graduate student a bridge between elementary accounts and the detailed specific texts and original papers, and thirdly, to present for qualified scientists and engineers engaged in research and development a survey of masers and lasers covering a fairly wide field." [Preface]

To achieve these objectives John S. Thorp, a member of the department of applied physics at the University of Durham, has arranged the book into five divisions. This first chapter introduces the general theory of stimulated emission, including the Einstein coefficients and population inversion. The author next discusses in detail maser theory, operation and applications. Solid-state, liquid, semiconductor and gas lasers are each discussed in some detail, with the emphasis on descriptive properties and applications. Before a concluding chapter on trends in research and development, the author includes four chapters on the nature and types of crystals suitable for both microwave and optical devices. Cgs and emu units are used throughout.

The author's principal research field is concerned with microwave receivers in the millimeter wavelength. Perhaps this fact explains the relative emphasis on masers. The chapters covering the ammonia maser and maser theory contain enough detail, both in the equations and diagrams, for the advanced worker in related fields. There is little background to microwave theory and no introduction to cavity theory. The author has marked especially difficult sections so the beginner can omit these at first reading. I find it difficult to understand why chapter 5 was so marked, as the material covering "Pulsed Solid State Masers" contained therein is neither abstract nor mathematically sophisticated. The author stresses the maser's amplification aspects, which certainly have many current applications.

The five chapters on lasers appear to be very thin compared with the ones on masers. There is very little to give the reader clues to the origin of the numbers. For example, reference is made to rate equations governing laser operation, but they are not specifically written out. There is little distinction made between cw and pulsed lasers,