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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Quantum oscillators

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

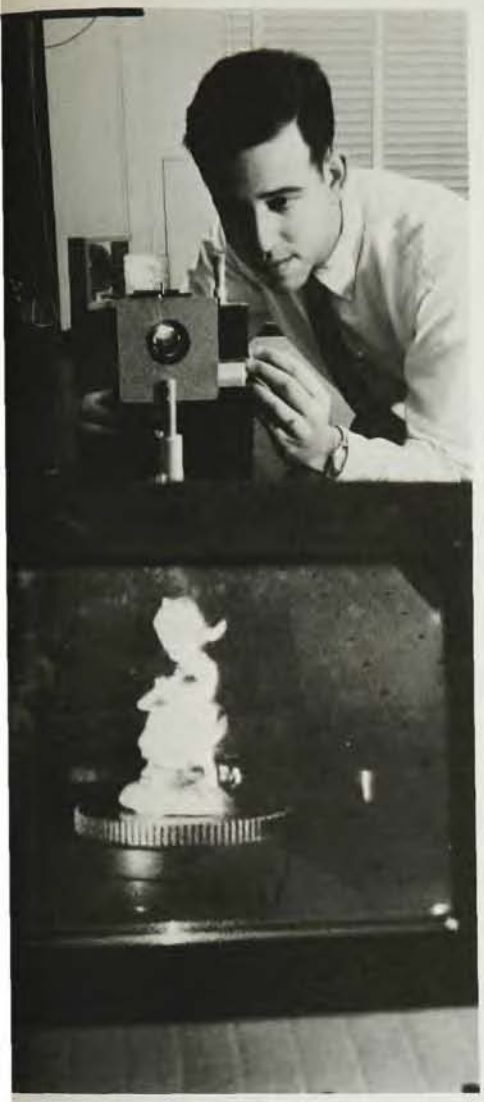
by Mary E. Cox

"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,



A NEW HOLOGRAM TECHNIQUE at Bell Laboratories allows the viewer to see a three-dimensional image rotate through a full circle simply by moving his head in front of the flat hologram. Viewing can be with a filtered white-light source.

either gas or solid state. As many diagrams are taken directly from the literature (often without sufficient references), the notation is not uniform. For example, in Figs. 7–2 through 7–4 the author uses energy units, while in Fig. 7–5 we have wavenumbers. On some of the energy-level diagrams there is spectroscopic notation, while on others Thorp uses group-theory notation. The general similarities of laser operations are presented clearly. However, the novel and unusual aspect of certain laser materials are barely touched upon. The emphasis is on the historically first operative system, rather than on the often physically simpler second-generation device.

The four chapters on the "science of maser and laser materials" (preface) deal with crystallography. For anyone purchasing crystals for laser or maser applications, these chapters provide a good start on understanding the requirements for such crystals. However, insofar as the author merely summarizes current work in crystallography, more detailed references ought to have been given. Optical tests of strains and variations in index of refraction with lasers and microwave cavities provide the most interesting and potentially useful material in this section.

Often mistakes, typographical errors, omissions and confusing notation such as those occurring in this book can be overlooked in the first edition of a book that is well written. Such is not the case with this text. Expository sections are poorly written, often with insufficient content. Undergraduate students would find this book poor reading. Advanced research scientists might find some sections of value. However, since there are several excellent volumes on lasers and masers currently available, it is unlikely that they would use this book.

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Illumination for undergraduates

AN INTRODUCTION TO MASERS AND LASERS. By T. P. Melia. 162 pp. Chapman & Hall, London (Barnes & Noble, New York), 1967. $5.50

by Robert J. Collier

The stimulated emission of little books bearing the title "Masers and Lasers" continues unabated. It would appear that there are many potential maser–laser book publishers in excited states and many potential authors capable of stimulating publication when they encounter excited publishers. Therefore the emergence of a maser–laser book is a highly probable event.

Terrence P. Melia, lecturer in chemistry at the University of Salford, has written an *Introduction to Masers and Lasers* aimed at the average science undergraduate. It is a pocket-sized book, and the text is necessarily abbreviated. After introducing some of the concepts basic to maser action and pausing briefly to describe the maser itself, Melia devotes the majority of the book to identifying a variety of laser forms. Separate short chapters are allotted to solid-state lasers, gas lasers, Raman laser action, semiconductor, chemical and chelate lasers. The longest chapter and perhaps the most instructive is the one concerned with semiconductor lasers. A final portion of the book sketches some laser applications and outlines what is known about laser health hazards.

By emphasizing the variety of ways in which laser action can be obtained, the author conveys a sense of the untapped potential for laser development and application. However, the broad-brush, rapid-passage, cover-all treatment requires care in its use, and there is evidence that this ingredient is missing. No attempt has been made to assess the relative significance of the various possible laser systems. Melia's little book fails to focus on those lasers that are of practical importance. For example, ". . . laser oscillation also occurs at 0.6328 μ . . ." is the only reference to the most widely used laser wavelength. Barely mentioned as a "Miscellaneous Gas Laser" is the CO_2–N_2 high-efficiency, high-power laser. The argon II ion laser, whose blue light is most useful for application to the laser surgery alluded to in Chapter 12, is not described at all. Nor is the YAG:Nd laser, the best of the cw solid lasers. These lasers were all on the scene in 1965 and should be prominent in any general laser book published by 1967 (see, for example, *The Laser*, W. V. Smith and P. P. Sorokin, McGraw Hill, 1966). The undergraduate reader may well be concerned with the value of his purchase upon discovering that such useful lasers, all commercially available now, were nearly invisible to Melia.

There is a general carelessness that tarnishes this book. On page 44, chapter 5, a discussion of the threshold condition is largely a reproduction of the text appearing on page 32 of B. A. Lengyel's book *Lasers* (John Wiley, 2nd printing, 1963). Quite likely an oversight accounts for failure to make specific mention of this. Most certainly lack of care is responsible for an error having been made in the transfer. (The condition for rapid buildup of radiation is $\alpha L > \gamma$, as Lengyel had it.) A further manifestation involves the figures. For example, it would be better to state explicitly that figure 7.2 and its caption as well as figure 7.7 are adaptations from an