PREFACE

In an emerging technology, textbooks and monographs may not become available for a number of years. In the meantime, a worker undertaking the study of a new subject finds his only introduction to be in the form of journal letters and short articles that would be difficult to understand even if much of this literature were not obsolete. The present volumes on infrared, far-infrared, submillimeter, and millimeter waves are intended to serve as personal textbooks for the professional engineer and scientist. The professional will wish each chapter to stand alone so that he will not be required to study the entire volume at the first encounter. The professional may also wish his book to have a theme—in this case, sources of radiation. Additional volumes will soon appear dealing with instrumentation and techniques, interaction of radiation with matter, and particular emphasis will be given to volumes on millimeter wave propagation, components, and systems. The nature of this sort of treatise is such that the emphasis will fall on new material, but an attempt will be made to avoid *perishable* new material. Somewhat older topics will also be reviewed, not for the sake of completeness, but to pursue the theme of the volume when the older material cannot easily be acquired by references to other sources.

Subsequent volumes will include new advances as well as basic material. Often new material first emerges at traditional conferences, such as the periodic International Conference on Infrared and Millimeter Waves (which will always be referred to as the Submillimeter Wave Conference) and the annual IEEE Microwave Symposium; the Electromagnetic Wave Propagation Panel of NATO will also play a role. The meetings of Commission D (Physical Electronics) of the International Union of Radio Science (URSI) accommodates topical sessions that will surely become traditional because of the well-known URSI hospitality to new technologies and areas of science. Indeed it has been the generosity and hospitality of the IEEE Microwave Theory and Techniques Society, the IEEE Quantum Electronics and Applications Society, Commission D of the International Union of Radio Science, and the Optical Society of

America that have made it possible to bring the workers in these areas together during these recent, formative years.

This first volume contains chapters on the important modern sources of radiation available for use in the far-infrared and near-millimeter wavelength range of the spectrum. Operating principles and comparative performance are emphasized. All three types of device are represented: electron tubes, solid state devices, and optically pumped lasers. The emphasis has been placed on the "here and now" devices, giving priority to the principles of operation for those who wish to get the most performance for their money. Most of these sources of radiation are available commercially, but this book should permit the reader to decide whether to "build or buy."

T. A. DeTemple's chapter on the optically pumped laser is a presentation of the principles and performance of a variety of models of high power pulsed lasers. The gyrotron is perhaps the most promising high power source and is described by a pioneer in its development, J. L. Hirshfield, although Bott's bottle and the work of the Soviet scientists are fully recognized. The best solid state device for power generation is the IMPATT and H. J. Kuno, representing the Hughes leadership in this field, has prepared a scholarly treatment. It would be difficult to argue that the carcinotron (backward wave oscillator) is not the best tunable source of radiation in the submillimeter wave range of the spectrum and it is certainly the best established commercial device. It is available only from the French firm Thomson-CSF, so our chapter has been prepared by G. Kantorowicz and P. Palluel of Thomson-CSF. As you open this book for inspection, turn first to their Fig. 1, which compares the output performance of *all* of the far infrared and submillimeter sources of radiation. It is an honest comparison: It does not show the Thomson-CSF carcinotron producing the highest power at the highest frequency, but it is very near to the top of both parameters. For the future, the very near future, please focus your attention on the development of the relativistic electron beam devices that have been described in a "state of the art" chapter by the recognized leaders in the field, P. Sprangle, R. A. Smith, V. L. Granatstein, and their colleagues at the U.S. Naval Research Laboratory. Finally, a neglected source of radiation, the ledatron, is described in a brief chapter by K. Mizuno, the organizer of the 1978 Japanese Submillimeter Wave Conference. Mizuno and D. H. Martin produced an incomparable review on tunable sources of radiation that was published only a few years ago. Then there is the obvious omission of the extended interaction oscillator and amplifier. There is no need to include a chapter on this topic. This commercial device is available from Varian Associates of

Canada,* and their standard brochure is an excellent chapter on the subject. Its performance is compared with other sources of radiation in Fig. 1 of the chapter by Kantorowicz and Palluel.

Finally, there are the Gunn oscillator and other microwave sources of radiation that will be extended into the millimeter and far-infrared region of the spectrum as solid state materials are improved. These subjects will be covered thoroughly in what is now planned as Volume 5, which is devoted to millimeter wave techniques and systems, and is scheduled to be published about 1981.

Future volumes in this edited treatise will fill some of the obvious gaps in sources of radiation. The chapter on continuous wave optically pumped lasers from 2 to 40 μm is being written by the best available authors on this subject, and will appear in the next volume.

As an editor, I am grateful to the contributors to these volumes and to their employers, who provided the atmosphere for their professional activity. I wish to express my personal appreciation (1) to Professor Benjamin Lax and the Massachusetts Institute of Technology and (2) to the United States National Science Foundation, which supported my own research for so many years, thus making it possible for me to participate in this new technology. Finally, I thank my wife Athena Fillios-Button for her patience during weekends when I do things like this.

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