PREFACE

This monograph, which is an integrated review of a series of recent publications dealing with radiative transfer theory, applied spectroscopy, radiation gasdynamics, and ablation phenomena has been prepared as an introduction for the use of the educated nonspecialist who is interested in the application of these fields of science to high-speed atmospheric entry.

Radiation gasdynamics is an excellent example of an interdisciplinary research activity which requires effective utilization of the following important fields of physical science: fluid mechanics, quantum mechanics, and statistical mechanics (with stress on quantitative spectroscopic investigations). The complexity of the required machinery mitigates against the idea that significant research contributions can conceivably be accomplished after short exposure to a "basic introduction." We have, therefore, not prepared an "introductory" survey by assembling, under one cover, the diluted contents of four or five standard textbooks. Instead, we have attempted to describe currently used methodology as employed by applied scientists who work actively in the field. It is our hope that the reader will gain an idea of the tools and complex machinery that are available for work in opacity calculations and radiation gasdynamics and that our abundant references to both current and classical literature will provide the motivation for the supplementary hard work that is always required before real familiarity can be achieved in an important area of pure or applied science.

The topical sequence of material presented in Chapters 1 to 7 should be suitable for detailed study by physicists and chemists with good backgrounds in quantum mechanics, statistical mechanics, and applied spectroscopy. Readers without special preparation in spectroscopy and quantum mechanics may find it useful to follow a somewhat different course of study. Thus, after examining the definitions and ideas which are summarized in Section 1-1, it is recommended that they proceed directly to the relatively straightforward considerations on elementary radiative transfer theory given in Chapter 2 (omitting Section 2-2D). The descriptive material in Chapters 3 and 5 may then profitably follow before a detailed examination of radiation gasdynamics (Chapter 6) and of ablation during atmospheric entry (Chapter 7). Serious study of the remaining topics in Chapters 1, 2, and 4 should preferably be deferred until after intensive exposure to more detailed, introductory treatments on quantitative spectroscopy.

We have taken special pains in making each of the chapters self-consistent, thereby permitting independent study of the topics treated by us, without the use of extensive cross-referencing. Thus a reader who is only interested in obtaining some opacity estimates for pure air should be able to find the desired information in Chapter 3; a reader who wants to familiarize himself with ablation theory may use Chapter 7 directly; etc. Some self-evident differences in notation occur between the various chapters, although a consistent notation has been used in any given chapter.

We are happy to express our sincere appreciation to the Physics Branch of the Office of Naval Research for long-term support of basic studies on gas emissivities, and to the Advanced Research Projects Agency of the Department of Defense for support of research in radiation gasdynamics and ablation theory. Without original studies in these fields of applied science, it would not have been possible for us to write this monograph.

The present monograph was completed in March 1965. Some minor changes and additions referring to later work have been made in proof. Chapters 1, 4, and 7 were written by S. S. Penner; Chapter 2 and Section 5.2 were written by S. S. Penner and D. B. Olfe; Chapter 3 is by S. S. Penner and J. C. Stewart (Joint Institute for Laboratory Astrophysics and Department of Physics, University of Colorado, Boulder, Colorado); Sections 5.1 and 5.3 to 5.5 were written by L. D. Gray (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California); Chapter 6 is by D. B. Olfe.

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